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VULNERABLE ATHEROSCLEROSIS PLAQUE FOR PREDICTING RISK FACTORS OF HEART ATTACK BY IMAGE PROCESSING

A.Jeba sheela[1], Francisca little flower.M[2]

[1]Assistant Professor, Department of Computer science and Engineering, DMI College of Engineering, Chennai, India
[2]Department of computer science and Engineering, DMI College of Engineering, Chennai, India.

Abstract— *A great challenge for imaging method is to visualize patient with high-risk lesions vulnerable plaque. To identify the intra plaque haemorrhage, It's a secondary to rupture the blood vessels of advanced plaque rupture and luminal thrombi. Numerous non stenotic lesions undergo expansion in overall plaque size without reduction in luminal area. An expansion later leads to myocardial infarction, which also refers to heart attack.*

Digital Imaging Processing introduces the concepts to find such plaque and prevent the risks at early stage. Hence we analyse the proposed technique for coronary atherosclerosis and we aim to develop an efficient image segmentation procedure. By using morphological operator such as dilation & erosion helps to remove unwanted background of the MRI image. The identification of physical properties such as radius, thickness and presence of plaque uses functions of the MATLAB. Finally, results shows the blockage in the arteries of heart thus, predicting heart attack at the earliest.

Keywords: Image pre-processing, Image segmentation, Feature extraction, Gaussian filter, LSSVM, heart disease, plaque

1. INTRODUCTION

Atherosclerosis is a vascular inflammation disease, which is the major cause of myocardial infarction (MI), stroke, and ischemic gangrene. These result from acute thrombus formation on the surface of a plaque. The majority of cardiovascular events occurs in asymptomatic subjects and classified as low to intermediate risk by current assessment algorithms. The algorithms include disorders such as family history, hypercholesterolemia, hypertension, obesity, and smoking., An extensive body of experimental work as well as histopathological, which refers to a microscopic study of tissues and clinical data, indicates the immune responses. Immune response leads to chronic inflammation and this process is integral to the pathogenesis of atherosclerosis.. Inflammation modulates the effect of lesion initiation, progression, and vulnerability to rupture. Atherosclerotic plaques containing a large number of macrophages are more vulnerable than plaques containing only few macrophages. Plaque rupture is a major cause of cardiovascular events such as, unstable angina, myocardial infraction and stroke. Moreover, hypoxia regarded as an important factor in plaque rupture. However, the degree of arterial stenosis weakly correlates to the vulnerability of plague. The identification of subjects at risk for cardiovascular events cannot have confidence solely on the assessment of anatomical severity of vascular stenosis.

This method consists of three steps: differentiation of the lumen and the arterial wall, segmentation of the lumen and arterial wall separately with region growing and detection of soft plaques based on operation performed on the arteries of the heart.

2. RELATED WORK

Atherosclerosis is a progressive disease, which begins in a childhood. Already in the first 6 month of life, about one-half of infants, have signs of atherosclerosis [21]. Early atherosclerotic lesions, known as intimal xanthomata or initial lesion or fatty streak, consist of sub endothelial accumulations of cholesterol-filled macrophages (foam cells) [20] [21]. In humans, such lesions are present in the aorta at first decade, in the coronary arteries in the second decade, and in the cerebral arteries in the third or fourth decades of life [11]. Attention directs at the evaluation of plaque characteristics and biological processes that determines the dangerous level. Various method including ultrasound, multisite computed tomography ,Magnetic resource imaging, Single photon emission computed tomography ,Intravascular Ultrasound, Optical Coherence Tomography and others ,are being evaluated to detect vulnerable plaques [18]. Enhanced imaging techniques may detect additional characteristics of plaques and novel predictive models may improve the assessment of plaque vulnerability in patients. Various factors play an important role for detecting atherosclerotic plaques. Some are High blood pressure, high blood cholesterol, Diabetes, Obesity and Overweight, Smoking, Physical inactivity, Heredity, Age. Plaques in arteries may cause flow-limited stenosis, which can lead to clinical complications. However, the most severe clinical events commonly cause by the rupture of a plaque, exposing the pro-thrombotic material in the plaque to the blood circulation. It leads to cause of sudden thrombotic occlusion at the site of artery disruption. This rupture prone plaque generally called as vulnerable plaque [20] [11]. For this, A.G.Roy, S.Conjeti, S.G.Carlier and A. Katouzian [2] has proposed "Lumen segmentation in intravascular optical tomography using back scattering tracked and initialized random walks" where it performs Intra vascular imaging is done by ultrasound or optical coherence tomography predominantly used to adjunct

the clinical information in interventional cardiology. OCT provides high resolution images for detailed investigation of atherosclerosis induced thickening of the lumen wall resulting in blockage and triggering acute coronary events. This paper presents a lumen segmentation method using OCT imaging physics based graph representation of signals and random walks image segmentation approaches. Optical backscattering maxima is tracked along each scan of OCT and is subsequently refined using global gray level statistics and used for initializing seeds for random walks image segmentation. High segmentation and accuracy and consistency substantiates the characteristics of this method to reliably segment lumen across pullbacks in the presence of vulnerability cues. However, the stochastic uncertainty of speckles limits effective visual investigation over large volumes of pullback data and clinicians challenge by their inability to investigate subtle variations in the lumen topology [1]. In the paper "Image analysis for detection of coronary artery soft plaques in MDCT images" using CT images computationally efficient image segmentation procedure has been proposed. This method consists of extraction of lumen centerline, segmentation of lumen and arterial wall separately with locally adaptive region growing [2]. In the paper "Noninvasive imaging of the vulnerable atherosclerotic plaque" by Gerrit.L.tenkate, MD,. Eric, J.Sijbrands, MD, Blai coll, MD presented a review systematically that investigate the accuracy of noninvasive imaging technique in the identification of plaque components and morphologic characteristics associated with plaque vulnerability, assessing their clinical and diagnostic value [3]. The above works have been improved by "Heart disease prediction using artificial neural network and image processing" where different image processing methods are used to get useful information from medical reports of patients using artificial neural network [9].

3. METHODOLOGY

The objective of this work is the development of an algorithm to automatically detect when a person is having a possible heart attack by analyzing images using image processing techniques. MRI imaging technique is used acquire heart image of a human. It ia a medical imaging technique used in radiology to image the anatomical and the physiological processes of the body in both health and disease condition.

The visual aspect of an artery depends on multiple properties such as its radius, its depth or the absorption and scattering coefficients of the tissue close to the vessel and the vessel itself. To predict the appearance of a blood vessel and the surrounding skin, the spatially and spectrally resolve reflectance for the skin surface near the vessel present in the visible wavelength range between 400 and 800 mm. The generation of an efficient and accurate LUT, delivering the spectrally and spatially resolved reflectance detected at the skin surface along a vessel. A variance reduction method is applied to accelerate the generation of the LUT. The appearance of the blood vessels renders in a two-dimensional image.

3.1 Input image

An image is a two dimensional signal. It is outlined by the mathematical function f(x ,y) where x and y are the two co-ordinates horizontally and vertically. The value of f(x, y) at any point is gives the picture element value at that point of an image. In this paper MRI images of heart is to determine the plaque or fat deposit in the arteries of the heart. MRI image data set is collected from the hospital and using image processing techniques detection of plaques in the arteries have been performed on the image.

3.2 Image preprocessing

Image Pre-processing is a term for operations with images at the lowest level of abstraction — both input and output are intensity images. The aim of pre-processing is a refinement of the image data that suppresses unwilling distortions or enhances some image features are important for further processing, although geometric transformations of images (e.g. rotation, scaling, translation) are classified among pre-processing methods here since similar techniques are used for noise cancellation

3.3 Image Segmentation

Image segmentation could be a remarkably used technique in digital image processing and analysis to partition an image into multiple elements or regions, typically based on the characteristics of the pixels in the image. Image segmentation could involve separating foreground from background, or clustering regions of pixels based on similarities in color or shape. For example, a common application of image segmentation in medical imaging is to detect and label pixels in an image or pixels of a 3D volume that represent a tumor in a patient's brain or other organs.

Several techniques for image processing has been developed over years using domain specific knowledge, which effectively solve image segmentation problems in that specific application areas. These areas include medical imaging automated driving, video surveillance, and machine vision.

3.4 Feature Extraction

Feature extraction is a type of dimensionality reduction technique that efficiently represents interesting part of the image as a compact feature vector. This approach is useful when image sizes are large and a reduced feature representation is required, which quickly completes the task such as image matching and retrieval.

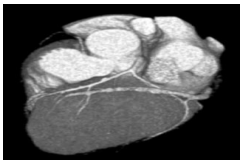
Feature is a piece of information about the content of an image, typically about whether a certain region of the image has certain properties. Features may be specific structures in the image such as points, edges or objects.

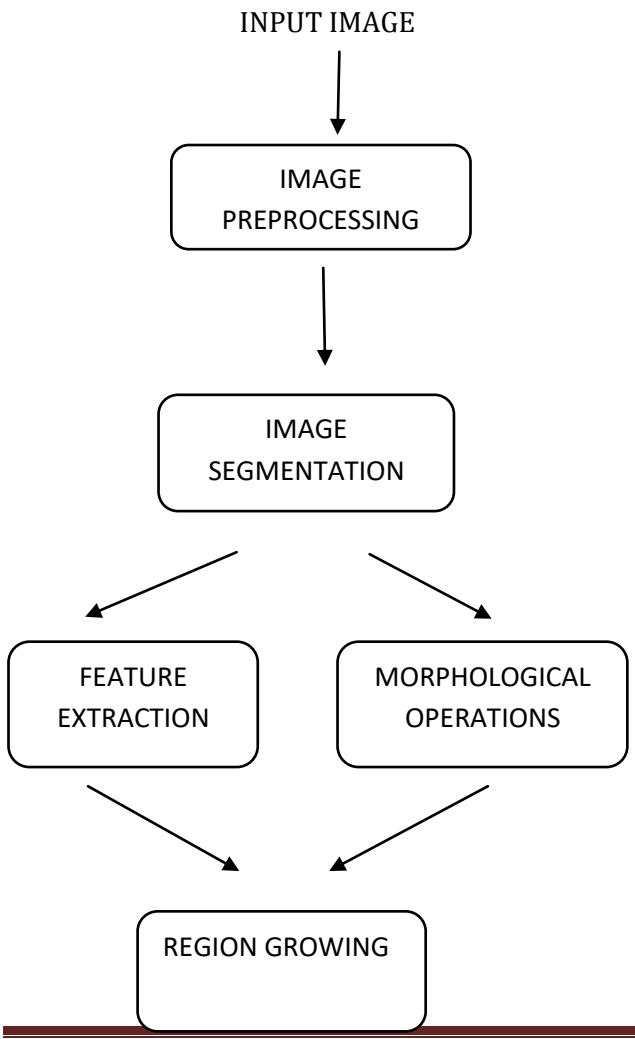
Deep learning models plays a very important role in automatic feature extraction models.

3.5 Morphological operations

Morphology in content of image processing means description of shape and structure of the object in an image. Morphological operations work based on the set theory and rely more on relative ordering of the pixel instead on their numerical value. This characteristic makes them more useful in image processing. The input information for the mathematical morphological operations are two images: raw image and primitive image. Morphological operation seem to define well for binary images but are equally valid and found useful for gray scale images also.

Morphological operations such as dilation, erosion, opening and closing of image play a major role in this project .Often combinations of these operations used to perform morphological image analysis .Morphological operation apply structuring elements to an input image creating an output image of the same size.





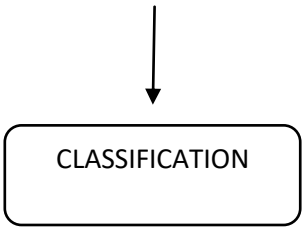


Fig .1 Block diagram of proposed system

3.6 Dilation

Dilation is a transformation that produces an image of the same shape but of a different size. Dilation stretches or shrinks the original image. Dilation increases the valley and enlarges the width of the maximum regions, so it can remove negative impulsive noises but do some positive one too. The dilation operation usually uses a structuring component for probing and expanding the shapes contained in the input image.

3.7 Erosion

The use of erosion helps to reduce objects in the image and It is known to reduce the peaks and enlarges the widths of minimum regions, so it can remove positive noises but affect negative impulsive noises little. The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels. Thus areas of foreground pixels shrink in size, holes within those areas become larger.

3.8 Opening

Opening eliminates small objects from the foreground usually taken as the bright pixels of an image, placing them in the background. The impact of the operator is to preserve foreground regions that have an identical form to this structuring element, or that can completely contain the structuring element, while eliminating all other regions of foreground pixels.

3.9 Closing

Closing eliminates area of dark pixels surrounded by light pixels in an image and, change small islands of background into foreground. The effect of the operator is to preserve background regions that have a similar shape to this structuring element, or that can completely contain the structuring element, while eliminating all other regions of background pixels.

3.10 Region Growing

Region growing is a simple region-based image segmentation method. It also classified as a pixel-based image segmentation method since it involves the selection of initial

seed points. This approach to segmentation examines neighboring pixels of initial seed points and determines whether the pixel neighbors contributed to the region in addition. The process tends to iterate in the same manner as general data clustering algorithms.

3.11 Classification

Support vector machine (SVM) associates with machine and regression analysis. Given a set of training samples, each marked as belonging to one or the other of two categories, a SVM training algorithm builds a model that assigns new examples. There are two categories namely linear and non-linear classifier. An SVM model is a representation of the examples as points in space, mapped so that examples of the separate categories are divided by a clear gap that is as wide as possible. New samples are then mapped into that same space and predicted to belong to a category based on the side of the gap on which they fall.

Linear Square Support Vector Machine (LSSVM) are least square versions of support vector machine ,which are a collection of related supervised learning methods that analyze data and acknowledge patterns. In this version one finds the solution by solving a set of linear equations instead of convex quadratic programming problems for classic SVMs. LSSVMs are a class of kernel learning models.

Least Square Support Vector Machine help to analyze the standard regression .Regression is the analysis of relation among dependent and independent variable .For example, Impacts of age, gender, height, weight etc. Least square approach mainly used for prediction and forecasting process. It depends on machine learning concepts and reduce the sum of squares.LS SVM also finds the best data from set of data

4. RESULT WORK

There are huge number of image processing techniques and algorithms which are used to dragonize heart disease. The following observations are made by implementing the above techniques on the images. The original image of heart is a MRI image (Fig 2). MRI is quite accurate in detecting blockages in the larger sections of coronary arteries. The input image is preprocessed using gray scale conversion and wavelet transforms .Wavelets are used in image processing to detect and filter noise due to their high contrast of pixel intensity. Gaussian filter is used to detect the edges of the images and blur the image for reducing noise signal to present a clear view of the image. Contextual thresholding is used for Image segmentation as it is more successful in separating individual objects as it accounts for closeness of pixels. Thresholding is used to convert a gray scale image into a binary image to separate an object in an image. Region based segmentation is used as it determine the regions directly and provide the original images that have a clear edge. It groups pixels or sub regions into larger region. This approach to segmentation examines neighboring pixels of initial seed points and determine whether the pixel neighbors contributed to the region in addition. Here it gives a clear image to view the blood arteries to detect the plaque present in it. Morphological operation are performed on the image for better view of the blockages in the arteries of the heart. Using these techniques the blockage in the arteries of the heart which is essential in detecting or predicting heart diseases mainly heart attack at an early stage.

Fig.2 MRI image of the heart

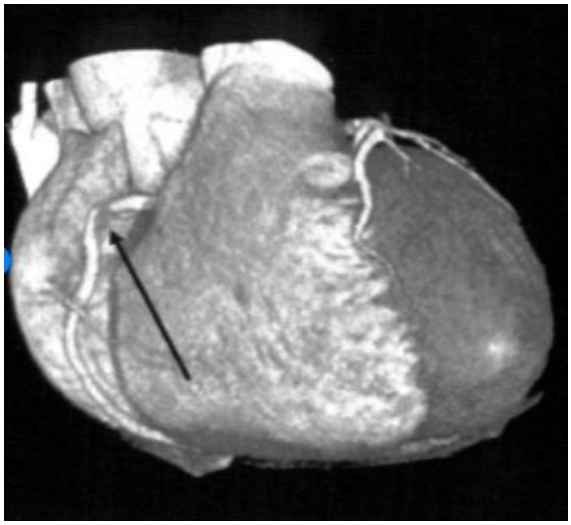


Fig.3 View of blood vessels of the heart

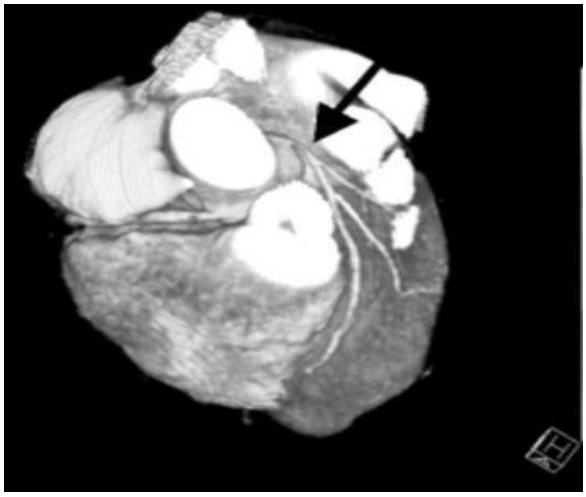


Fig.4 Detection of plaque

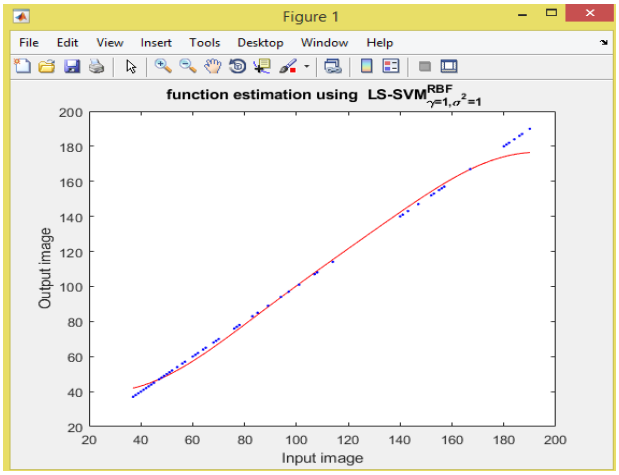


Fig.5 Graph of the input and output image

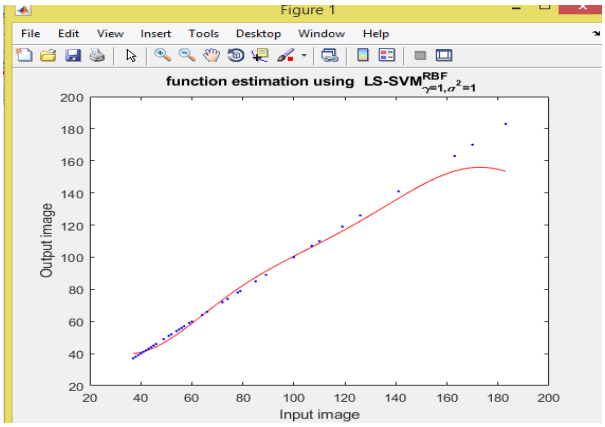


Fig.6 Graph of the input and output image

In the figure 5 and 6, LSSVM classifiers uses input and output images for graph plotting.an input image is represented in x-axis and output image is represented in y-axis. The matching level of pixels indicates very close representation of dotted lines. Regions of blocks or presence of plaques can be identified by the graph.

5. CONCLUSION

The vulnerable Aethrosclerosis plaque is harmful to human beings,which causes heart attack.Thus the presence of heart thrombus andand clear visual of heart is viewed using morphological operations such as dilation and erosion.Region growing plays an important role for finding complete and clear images of blood vessels.LS SVM graph is used to plot the graph between input and output image.The blockages or fats are analyzed using LS SVM graph.

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