Abstract - Intravascular Ultrasound Image (IVUS) is one of the medical imaging techniques based on the catheter. These techniques are very useful for studying heart diagnose and management of arterial atherosclerosis. It produces the vessel cross sectional images of blood vessels that provide the quantitative and qualitative assessment of the vascular wall information about the nature of atherosclerosis lesions as well as plaque size and shape. The identification of lumen, media and adventitia boundaries in IVUS images is necessary for an efficient assessment of the atherosclerotic plaques. During an IVUS examination, a catheter with an ultrasound transducer is introduced in the body through a blood vessel and then pulled back to image sequence of vessel cross sections. This paper presented a one of the attractive and interactive methods is the Active Contour Model (ACM) with Local Image Fitting Energy Minimization (LIFEM) method which has been widely used in medical imaging technique as it always produces computationally efficient for sub-regions with continuous boundaries. In our approach maintains and deals with the boundary regularization property and sub-pixel accuracy.

Index Terms - IVUS cross sectional image, plaque, blood vessels, atherosclerosis, lumen, media, transducer, Active Contour Model.
image of the cross sectional coronary arteries shown in Fig 1 and to see their condition. The ultrasound sound waves travel through a tube called catheter. The catheter is threaded through an artery and into your heart. This test lets doctors to be look inside your blood vessels.

IVUS uses high frequency sound waves that can provide a moving picture of heart. The pictures come from inside the heart rather than through the chest wall. The ultrasound sound waves are sent with a device called a transducer. The transducer is attached to the distal end of the catheter which is threaded through an artery and into the heart. The sound waves bounce of the walls of the artery and return to the transducer as echoes. The ultrasound echoes are converted into images on a Televisions monitor to produce a picture of cross sectional coronary arteries and other vessels in your body.

II. IVUS WORKING PROCEDURE

IVUS used in echocardiography technology, the same technology in ultrasound image treadmill tests and many other medical exams. The high frequency sound waves are used in ultrasound imaging systems that are emitted by a transducer. These ultrasound waves of tissue structure in the body and the echo are converted into picture. IVUS transducers have been miniaturized to less than four hundredths of an inch and placed on the tip of a catheter. This catheter can be slipped into the cross sectional coronary arteries over the same guide wire that is used to position angioplasty balloons or stents in coronary arteries and vessel walls. It becomes, in effect, a tiny camera that gives us a cross-sectional view of the coronary artery, the coronary artery view that shows the distinct circular layers, using shades of colors and gray, the major ones being the following.

1 The adventitia is the outer covering of the artery. 2 The media is the actual wall of the artery, 3 the intima is the layer of endothelial and other cells that make direct contact with the blood inside the artery – in normal arteries layer is thin but in diseased arteries are shown in Fig 2 thickened by plaques. 4 the lumen is the actual open channel of the artery through which the blood flows.

III. IVUS IMAGE ACQUISITION

Nowadays, there are two major kinds of IVUS devices available for acquisition. First device called as mechanically driven catheter and second device called as solid state devices. Mechanically driven catheters device consist of a flexible sheath, a core which contains the transducer in its tip and an external motor which is used to rotate the core. Solid state device generates the images from a transducer array and contain no moving parts. Mechanically driven catheter has the major advantage of a stable pullback path.

IV. IVUS IMAGE PRE PROCESSING

Three steps of pre-processing are used for the purpose of the contour detection which is representation of ivus images in polar coordinates, detection of catheter region and replacing it by mean intensity value of the whole image and edge preserving and smoothing. Image representation in polar coordinates is essential to facilitate the efficient description of local image regions in the radial and tangential direction. Representations of the IVUS cross sectional images in polar coordinates shown in Fig 3. It is important for facilitating the description of local IVUS image regions in terms of their radial and tangential characteristics and it also facilitates a number of other detections steps of IVUS images, such as contour initialization and the smoothing of the obtained contour. This image representation is also applied for the contour initialization and an easier smoothing of the obtained contour [2]. Therefore, the original IVUS image (in Cartesian coordinate [x, y]) shown in Fig 4 is transformed into polar coordinate image and where columns and rows

![Figure 1. Cross sectional coronary arteries](image1)
![Figure 2. Cross sectional IVUS images](image2)
correspond to angle $\Theta$ and distance $r$ from the centre of gravity of the catheter, respectively. This polar image denoted by $I(r, \Theta)$, is used for the remainder of the analysis process.

Detection of catheter regions shows not only vessel wall and surrounding tissue, but also the border of the transducer of the catheter. The latter region defines a dead zone which contained no useful information. Having the diameter $D$ of the catheter, the catheter induced artifacts are easily removed by setting $I$ of distance $r$, angle $\Theta = 0$ for distance $r < Diameter/2+e$, where $e$ denote a small constant. This region can be substituted with the average value of the whole image pixel intensities.

Edge preserving and smoothing algorithms used to detect the speckle noises in IVUS images and also preserving the IVUS image details. It is one of the robustness for speckle reduction and edge enhancement processing.

![Image](image1.png)  
**Figure 3.** Original IVUS image (left) and polar coordinate image (right)

![Image](image2.png)  
**Figure 4.** The basic form of active contour

V. ACTIVE CONTOUR METHOD

One of the attractive methods namely called as the Active Contour Model (ACM) with local image fitting energy plays a vital role in IVUS image segmentation which has been widely used in medical imaging as it always produces sub-regions with continuous boundaries of objects [3] [4]. An active contour model is one of the energy minimizing function which has been used to detect the specified features within an Object. It is a flexible curve or surface which can be dynamically adapted to required edges or objects in the image. It consists of a set of control points connected by straight lines, as it is shown in fig 4. The active contour model is defined by the number of control points. Active contours to shapes in images are an interactive process. The user must suggest an initial contour of an object, as it is showed in Fig 4, which is quite close to the intended shape and the contour will then be attracted to features in the image extracted by internal energy creating an attractor image.

Active contour (a set of the coordinates of control points on the contour) is defined as Where $x(s)$ and $y(s)$ are defined in the sense of $x, y$ are the coordinates of past the contour and $s$ is the normalized index of the control points, as it is shown in eq1. Contour finding is one of the steps to find out the contour [5] [6]. There are different types of steps are to be followed by finding the contour such as pre processing the image, edge detection, contour detection of an image, delete the redundant points in an image, simplify the contours [7] [8]. Active Contour method is also called as snake [9] [10]. It is one of the frameworks for delineating an object outline [11]. The framework attempts the energy mininization and also associated to the current contour as a sum of the innermost energy and outermost energy [12] [13].
VI. PROPOSED ACTIVE CONTOUR WITH LOCAL IMAGE FITTING ENERGY MINIMIZATION (LIFEM)

A simple active contour with local image fitting energy is thus defined by a set of n points. LIFEM can easily manipulate using external image forces. It can be made sensitive to image energy function. Two types of energy functions to be defined by snake method which is the innermost (int) elastic energy form and an outermost (out) edge based energy form. Energy minimization function exhibits the dynamic behaviour. The assignment is to design and write to a program that can be performed some operations as object recognition and image segmentation through a technique called the active contour /snake method. Active contour model with local image fitting energy minimization used to iteratively fits itself around the boundary of an object in an ivus image and provide the approximation for finding points that minimizes an energy function representing the properties of image object. 3 parameters can be initialized by the contour method which is continuity, curvature and gradient. Energy function can be written in the following form shown in eq 2.

\[
E^{\text{snake}} = \int E_{\text{out}}(z(s)) ds = \int \left( E_{\text{int}}(z(s)) + E_{\text{image}}(z(s)) + E_{\text{con}}(z(s)) \right) ds
\]

Here \(E_{\text{out}} = E_{\text{image}} + E_{\text{con}}\) Where \(E_{\text{int}}\) represents the internal energy of the snake contour method, \(E_{\text{image}}\) denotes the image forces acting on the snake and \(E_{\text{con}}\) serves the external forces introduced by user. The combination of \(E_{\text{image}}\) and \(E_{\text{con}}\) represents the \(E_{\text{out}}\) which denotes the external energy features can be calculated by using the above method. \(E_{\text{image}}\) forces can be divided into three components Lines, edges and terminations are used to adjusting the weights in the image will determine salient features in the image which will be considered by the snake model. Final energy calculation can be formation by using the following.

Before entering the calculation of plaque formation first iteration can be calculated by using \(E_{\text{ext}}(zi)\) and the derivatives of this \(\omega, t, x \) and \(y\) separately. At the start point of the iteration, calculate \(\partial^2 x/\partial s^2(zi)\) and \(\partial^2 y/\partial s^2(zi)\) using the three adjacent points and \(\partial^4 x/\partial s^4(zi), \partial^4 y/\partial s^4(zi)\) using five adjacent points. At the end point of iteration these systems calculate change in x and y for each point in \(zi\) use the pre calculated \(E_{\text{ext}}(zi)\).

VII. RESULTS & DISCUSSIONS

In this system taken the IVUS cross sectional images for segmentation. This system used to calculate the energy minimization function using snake method with local image fitting energy. It provides the iterations to be taken for the each plaque formation. Nearly 1000 iterations can be calculated by using energy minimization method and time will be calculated shown in Fig 5 and Fig 6.

The IVUS is a catheter-based technique for visualizing arterial geometry and morphology. This study presents a new, automatic method for blood vessel cross-sectional analysis of the IVUS images, based on the use of texture operators and morphological processing. The method integrates different image processing techniques with specific knowledge of blood vessel anatomy collected from this particular type of images. By using this knowledge through all processing stages, this system has obtained reliable and accurate analysis results. The method, which is intended for clinical use, had to meet the following critical requirements: robustness, efficiency, accuracy, complete automatization, and low cost. The approach is robust, because it can handle a variety of input images. Most of the image degradation factors were incorporated in the morphological model of the vessel contours giving the segmentation result unaffected by noise, distortions, or poor image quality. The method is efficient enough for low-cost implementation, due to the selection of simple, yet accurate, texture operators. The processing speed is also increased by applying a concept of hierarchical thresholding. Consequently, all component labelling, object extraction, object filling, and morphological opening procedures were performed as binary operations between two regions or on the single contour.
This chart shown in Fig 7 the iteration and time can be calculated using energy minimization function for IVUS image. Energy minimization function can be used compute the shape parameters for the luminal, media, adventitia and plaque border. An active contour energy minimizing function that detects specified features within an image. It is one of the flexible surfaces which can be dynamically adapted to required edges or objects in the IVUS image (it can be used to automatic objects segmentation). The method which is intended for clinical purpose and that can to be met the following critical requirements: robustness, efficiency, accuracy, low cost and complete automatization. The following parameters which is cross-sectional area (CSA), mean diameter (D) calculated by using 2 Root CSA /π , circular shape factor (CSF) shown in eq 3, and percentage of diameter (SD) and area (ScsA) stenosis. The mean diameter (D) represents the diameter of the circle that has the same area as the observed contour of an image. The circular shape parameter is defined as the inverse square ratio between the observed perimeters of the image and the perimeter of the circle with the same area.

\[
\text{CSF} = \frac{\pi D}{\text{Observed parameter}} \left( \frac{\pi D}{\text{Quantities Obtained}} \right)^2
\]  

(3)

\[
\text{Diameter Stenosis} = \left( \frac{\text{Diameter}_{\text{Indexes}} - \text{Diameter}_{\text{Quantities Obtained}}}{\text{Diameter}_{\text{Indexes}}} \right) \times 100
\]

(4)

Diameter stenosis shown in eq 4 of the cross sectional IVUS images have been computed and area stenosis has shown in eq 5 where computed according to: where indexes m and I represents in the above equations mentioned the quantities obtained from media, adventitia, lumen, plaque and intima contours.
VIII. CONCLUSION

In this system that detects the IVUS images by use of the minimization of energy method. This method is effective to initialize the contour of an image. This is one part of the work plaque structure segmentation in IVUS cross sectional images. In future work this system will be implemented find out the all layers and segment the each layer in the IVUS images and finely find out the exact region of the plaque structure in IVUS images. This system iteratively fits the image regions and also provide by the approximation of the shape points that minimize the energy function representing the properties of image object.

REFERENCES