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Fuzzy Inference Model for the Detection of Coronary Artery Blockage in Non Invasive Imaging Modalities.

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Abstract:- Coronary artery plays a pivotal role in our cardio system. Any type of hindrance in that part could lead to fatal cardiac arrest. Many researchers have done work for the detection of the calcification in CA but none of them have taken the fuzzy inference aspect (one of the most important) which could result for its robustness. Cardiologists now want to have an automated system which could better detect any image linked with plaque formation. With this need, the present paper is an attempt to develop a comprehensive fuzzy inference system for the detection of coronary artery blockage in non invasive imaging modalities.

I. Introduction

Coronary Artery Disease (CAD) is being treated as one of the most challenging disease in today's era. Almost seventy million Indians have CAD and thirty million have had a Myocardial Infraction (MI). CAD happens because of atherosclerotic occlusion of the coronary arteries. Half of all deaths basically are due to Cardio Vascular Disease (CVD).

The coronary blood flow highly relies on perfusion pressure and vessel resistance .The mathematical representation of Coronary Blood Flow (CBF) can be represented as follows:-

CBF ∝ Perfusion Pressure (PP) ... (i) CBF ∝ 1/Vessel Resistance (VR) … (ii)

Coronary Perfusion (CP) is directly linked with diastole, so diastolic pressure is important. Coronary artery loses the power to release the vascular materials which allow the growing of CP as the demand increases. Various aspects of myocardial oxygen consumption are as follows:-

Contractility
Heart rate
Ventricular Wall Stress (VWS)

The most important one of the above is heart rate. The stress on Ventricular wall is defined by Laplace's Law. The mathematical representation of the above can be given as follows:-

VWS= [Left Ventricular Systolic Pressure (LVSP) * radius of Left Ventricle (LV)] /wall thickness ... (iii)

As the number of patients with heart disease increases very rapidly, so there is a great need to develop radiologic tools for non-invasive imaging of the coronary arteries. Today,MRI ,computed tomographic (CT) techniques are available with high speed and spatial resolution with sophisticated electrocardiographic (ECG) synchronization and robustness of use. According to the various authors, this technique gives very good result in coronary artery stenosis but cannot be used for routine diagnostic. For this reason, some sophisticated techniques are required for precise diagnosis of CAD.

II. Literature Review

As the number of patients with heart disease increases very rapidly ,so there is a great need to develop radiologic tools for non-invasive imaging of the coronary arteries. Now a days computed tomographic (CT) techniques are available with high speed and spatial resolution with sophisticated electrocardiographic synchronization and robustness of use. According to the authors this technique gives very good result in coronary artery stenosis but cannot be used for routine diagnostic.

International Journal of Computer Science & Information Technology (IJCSIT), Vol. 2, No. 1, Serials Publications, New Delhi, 2009 An Effect of Spatial Filtering in Visualization of Coronary Arteries Imaging.Dr. P.S. Hiremath1, Mr. Kodge B.G.2 1. Professor & Chairman, Department of Computer Sci. Gulbarga University, Gulbarga. State: Karnataka (INDIA) hiremathps@hotmail.com 2. Lecturer, Department of Computer Science, S. V. College, Udgir - 413517, Dist. Latur State: Maharashtra (INDIA)

In today's world ,we use coronary angiography for the detection of problem in coronary artery. In the conventional coronary angiography the procedure is no doubt invasive but has small risk of myocardial infections, stroke and death. On the other hand different non-invasive tools such as electrocardiography, echocardiography, and nuclear imaging are also used by cardiologists. These tools also have limitations in visualizing and quantifying coronary artery stenosis and predict the stability of plaques. One another non-

invasive visualization technique for coronary arteries is available which is known as Coronary magnetic resonance angiography (MRA).This tool is in a developing stage with limitations and cannot be used for routine clinical practice. if research is done on improving the diagnostic resolution and accuracy of coronary MRA then it will give better results as compare to other existing tools. This paper will helps to cardiologists to take the clear look of spatial filtered imaging of coronary arteries.

Volume 3, Issue 8, August 2013 ,ISSN: 2277 128X International Journal of Advanced Researchin Computer Science and Software Engineering Research Paper Available online at: www.ijarcsse.com Calcification Detection in Coronary Arteries Using Image Processing Pankaj Goyal*KuldeepGoyalVipin Gupta Department of Electrical Engineering,Scientist, DIPR, Defence R & D Senior Scientist, Philips DCRUST Murthal,Organization (DRDO), Research, ManyataTechSonepat, India Delhi, India Bangalore, India
This technique only highlight the regions containing coronary arteries by using vessel enhancement diffusion filter in to the two dimensional DICOM (Digital imaging and Communications in Medicine) images taken from the 64-slice Computed Tomography Scan data of the heart. As in this angiography we are using 64-slice CT scan machine so we get better visualization of coronary arteries using a small dose of contrast .This was not possible with early techniques.

Standardized evaluation methodology and reference database for evaluating coronary artery centerline extraction algorithms Michiel Schaapa , et.al.

Authors have used CTA for reliable data in clinical practice. Various methods where used but no standard methodology has been published for the evaluation and comparison for various extraction algorithms used in coronary artery .The authors have used four fold mechanisms for establishing the bench mark for the extraction algorithms.

III. Objectives

1. To analyze and interpretate various non-invasive imaging modalities related to CVD using fuzzy system.
2. To propose FIS for various image processing tasks particularly used for Cardiac imaging.
3. To simulate the above processes involved in the detection of blockage found in coronary arteries.

IV. Research Methodology

Step-1 We have undergone to the depth of heart anatomy and its physiology to know about various heart diseases and its consequences particularly taking the case of CHD.

Step-2 We have unfolded all the possible parameters which are responsible for CAD.

Step-2.1 We have investigated quantitatively all the factors related to CAD (Fuzzy Modelling).

Step-2.2 Inclusion of fuzzy logic and enhancing the present model to fuzzy based model for better blockage detection for realistic results.

Step-3 The input image is pre-processed and normalised for the further processing.

Step-4 After the normalization of the images, it undergoes for feature extraction using proposed fuzzy inference systems methodologies.

Step-5 Membership function has been generated for the real time values of the images.

Step-6 ROI is being analyzed and processed by using the proposed Fuzzy inference technique.

Step-7 Automated systems results were being validated with the actual output of the cardio images.

V. Experimental Setup

The present research has been carried out using MATLAB R2013b taking 32-bit Windows 7 professional SP1 as operating system. The processor used is Intel® Core™2 Duo CPU T6570 @2.10 GHz, RAM 2 GB. The primary data has been taken from XYZ hospital (name of the hospital and the patient have not been disclosed due to their request) in DICOM image format. Sample of 20 images of the various stages of calcified images of CA has been considered and the same number of sample has been taken for the healthy patients. The age group taken in the primary sample source is in the range of 65-85 yrs and sex considered is both Male and Female.

VI. Results and Discussions

The following image is a DICOM Image of a female heart taken by a snap shot of CORO 4/50 frame shot.

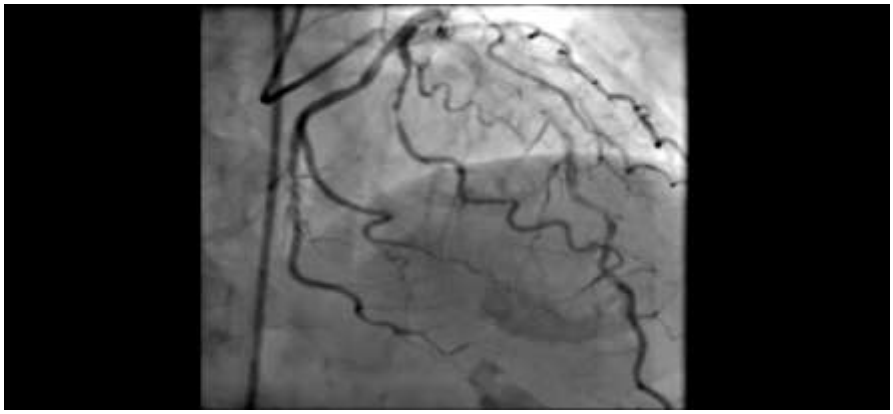
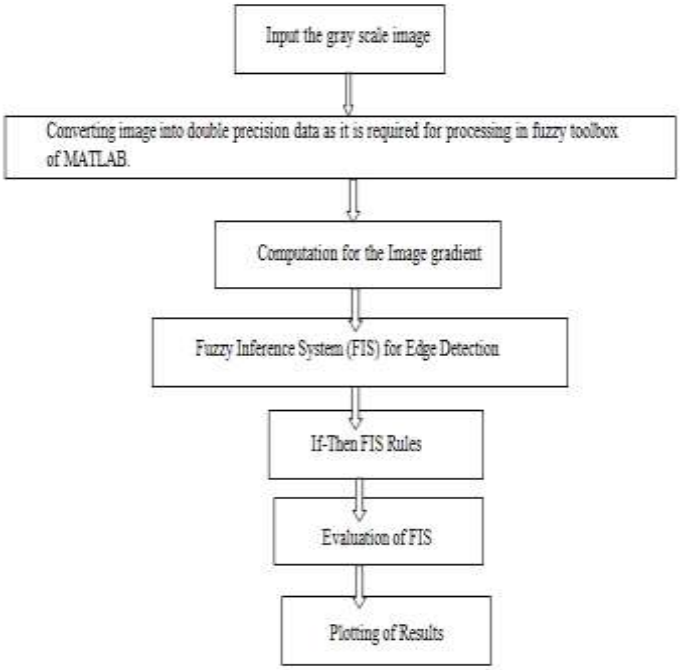


Fig 1. Snap Shot of CORO 4/50 frame shot.

Following is the DICOM information details of the input image.

Tag Info	Attribute Name	Attribute Value
(0008,0005)	Specific Character Set	ISO_IR 100
(0008,0008)	Image Type	DERIVED, PRIMARY, SINGLE PLANE, SINGLE A
(0008,0016)	SOP Class UID	1.2.840.10008.5.1.4.1.1.12.1
(0008,0020)	Study Date	4/19/2014
(0008,0021)	Series Date	4/19/2014
(0008,0022)	Acquisition Date	4/19/2014
(0008,0023)	Content Date	4/21/2014
(0008,0030)	Study Time	11:27 AM
(0008,0031)	Series Time	11:48 AM
(0008,0032)	Acquisition Time	11:48 AM
(0008,0033)	Content Time	2:25 PM
(0008,0060)	Modality	XA
(0008,0070)	Manufacturer	Siemens
(0008,1010)	Station Name	AXIS01332
(0008,1030)	Study Description	CARD
(0008,103e)	Series Description	Coro 20
(0008,1090)	Manufacturer's Model Name	AXIOM-Artis
(0008,2111)	Derivation Description	Compress Pegasus JPEG Lossless
(0008,2142)	Start Trim	1
(0008,2143)	Stop Trim	65
(0008,2144)	Recommended Display Frame Rate	15
(0010,0020)	Patient ID	2156UHID15482
((0010,0040)	Patient Gender	F
(0010,1010)	Patient's Age	076Y
(0010,4000)	Patient Comments	CAG
(0018,0040)	Cine Rate	15
(0018,0060)	kVP	73
(0018,1000)	Device Serial Number	135181
(0018,1020)	Software Versions	VC21B 130527-2
(0018,1030)	Protocol Name	Coro 20
(0018,1063)	Frame Time	66.6666667
(0018,1110)	Distance Source to Detector	1016
(0018,1111)	Distance Source to Patient	683.27964
(0018,1114)	Estimated Radiographic Magnification Factor	1.4869461
(0018,1150)	Exposure Time	383
(0018,1151)	X-ray Tube Current	756
(0018,1154)	Average Pulse Width	5.9
(0018,1155)	Radiation Setting	GR



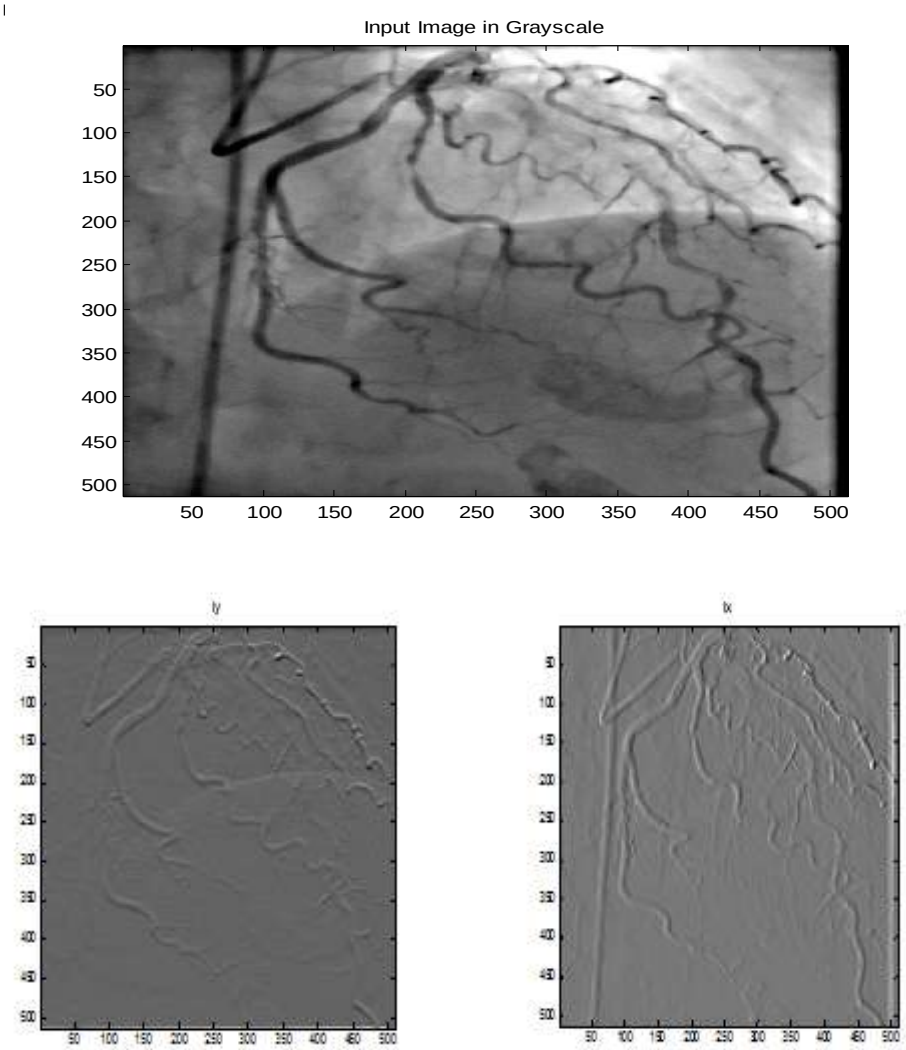


Fig 3 & 4 – Image gradients corresponding to both the axis

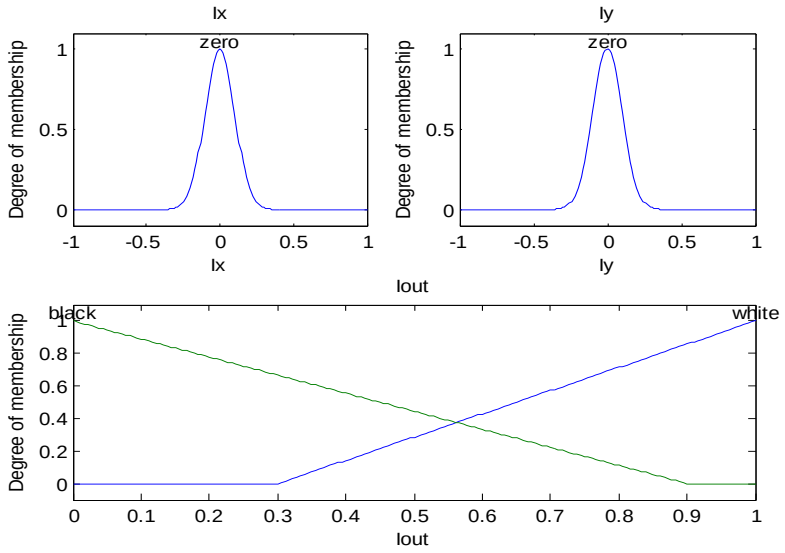
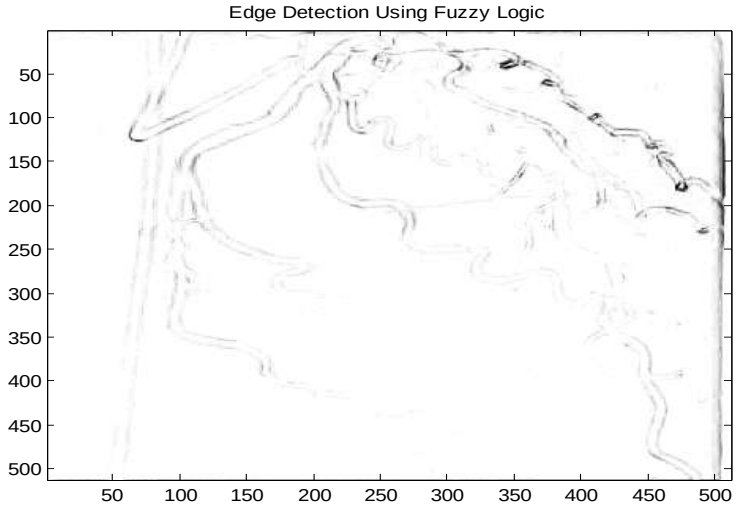


Fig.5 – Feature extracted output of the blockage image.



VII. Conclusion

The present research is a boost for cardiac Imaging researcher in the way that better results have been obtained using soft computing technique. We have investigated every parameter related to cardiac non-invasive imaging modalities. The image processing aspects have been dealt in accordance with the need of the cardiologist .The final output is promising for the early detection of CAD.

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