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EFFICIENT APPROACH OF CARDIAC CATHETERIZATION IMAGE ENHANCEMENT

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ABSTRACT

Cardiac catheterization is the process of inserting a tube called a catheter into the heart through an artery such as the femoral artery or aortic artery to reach the left ventricle of the heart or coronary arteries for diagnostic purposes such as ventricular injection left or coronary arteries that can facilitate X-ray vision or the introduction of therapeutic equipment. Image enhancement will be represented as one of the main areas of interest of most of researchers. For human interpretation the subjective quality of images is so important. Thus different image enhancement techniques have been used to provide a better diagnosis. The aim of this paper is how to enhance the visualization of the cardiac image to be more suitable to the doctor in order to make a correct decision for the patient. This implemented system can be divided into many steps including preprocessing, enhancement and decision making. The focus of this research is on how to improve the features of the image so as to be clear to the doctor. Two types of filters (Gaussian and Average) were applied and then the results were compared for both types. The Gaussian filter showed better results in improving the image parameters.

Keywords: *2D-DWT, Image Enhancement, Cardiac Catheterization, Image Visualization, Image Filtering.*

1. INTRODUCTION

In current days, fitness tracking is a vital phenomenon for diverse clinical programs [1]. Early detection of health risks becomes essential issue to research, apprehend and correct the various sicknesses [2]. Image processing performs a important role in early diagnosis of diverse illnesses [3]. In modern-day research there are wide quantity of algorithms which can be designed to screen and diagnose numerous scientific risks [4][5]. Early cardiac blockage detection is one most of the various scientific risks [6]. Efficient algorithm(s) needs to be developed to triumph over such type of medical hazards [7]. Cardiac blockage is a term commonly used by patients referring to coronary artery disease [8], a buildup of plaque-inflicting narrowing of the arteries that deliver the heart muscle with blood [9]. This coronary heart blockage, if extreme enough can affect the muscle getting the blood it wishes to function [10], mainly, when greater blood drift is needed together with whilst exercising, leading to signs along with chest ache and shortness of breath [11][12]. Fig.1. suggests the image of Human coronary heart, indicating the Cardiac Blockage which happens due to the accumulation of plaque in the artery walls. In addition, the plaque may also buildup in any of the vessels sporting blood cells. If you want to pick out or come across such form of Cardiac or coronary heart or Coronary Blockages, the Coronary Angiogram have to be performed for you to come across the Cardiac Blockages. The Coronary Angiogram is a special X-ray test that uses long, thin and hollow tubes called Catheters [12]. This process is performed to find out if any of the coronary arteries are blocked or narrowed, where and by how much. An angiogram can help the doctor to diagnose if the patient needs treatment such as angioplasty or stent, coronary artery bypass

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surgery (CABG) or medical therapy [13]. The Angiogram is also called as Cardiac Catheterization [13].

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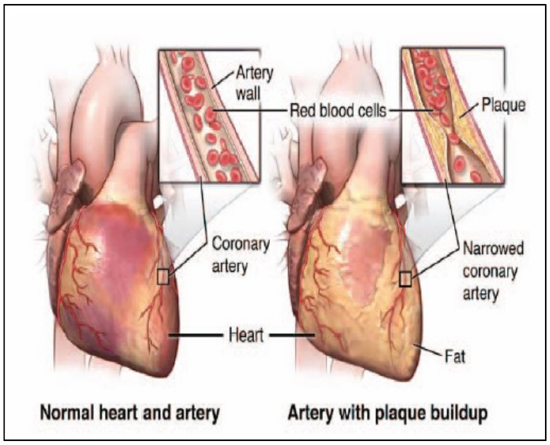

Figure1: Human Heart

Fig.2. shows an Angiogram photo of human heart and indicating some blockage point as depicted within the Fig. 1. This Cardiac Catheterization i.e. Angiogram test includes more headaches during the detection of Cardiac Blockages, on account that, it possesses invasive and complicated approach [7].Cardiac Catheterization is a costlier and dangerous approach achieved for the blockage detection [13].

The important fitness problem i.e. Cardiac Blockage detection and it's visualization is accomplished by using suitable photograph processing set of rules(s) (i.e. canny aspect detector and watershed) carried out on FPGA [14][15] with a modern technique and appearing optimization for the betterment of primary parameters called velocity, energy and place considering the fact that, these parameters are very crucial in each area.

Iimage enhancement will be represented as one of the main areas of interest of most of researchers. For human interpretation the subjective quality of images is so important. Thus different image enhancement techniques have been used to provide a better diagnosis. The objective of image enhancement is to improve the quality of image by reducing the noise of image, artifacts and preserve the image details.[16].

In the health care sector, image enhancement has received considerable attention because high-

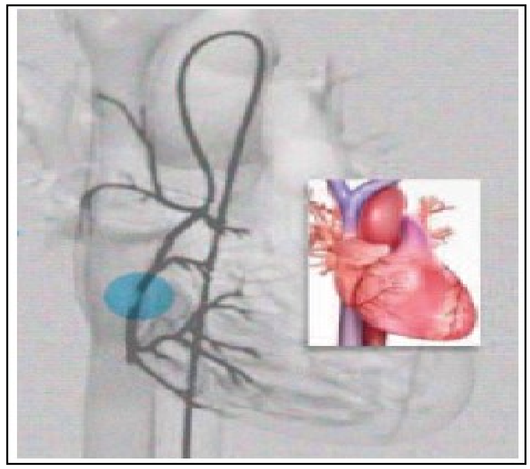

Figure2: Angiogram Image of Human Heart

quality images help physicians and medical staff to improve assessment accuracy [17].

The process of improving image quality is called image enhancement. This process can be performed by dimming or brightening the image, or by adjusting image contrast. Image enhancement is important for further image processing, such as segmentation and texture analysis, or text recognition [18].Most of the medical images (Ultrasound; MRI, X ray, and CT scan) have low contrast and improving the visual perception of these images is quite a challenge[19].The Image enhancement as a whole process will comprise the enhancement in each of contrast, intensity and color parameters. one of the essential factor responsible for image quality is Contrast which is refers to finer details of an image. Lighting, weather, distance, or equipment used for image capture has a direct impact on Image clarity thus the outcome of Image enhancement will be affected by those factors[20].Contrast enhancement plays a crucial role in many image processing applications, such as digital photography, medical image analysis, remote sensing, and machine vision. The main goal of image enhancement is to improve the subjective quality of the image [21]. One of the parameter to apply image enhancement is by manipulating the image contrast [22]. Contrast enhancement techniques such as histogram equalization (HE), adaptive histogram equalization (AHE), and contrast limit adaptive histogram equalization (CLAHE) have been widely used to improve the contrast in medical images [23][24]-[28].For any subjective evaluation of image quality the contrast issue will be represented as an essential factor.

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The two main images enhancement technique are spatial domain methods and frequently domain methods. Image enhancement in spatial domain means modifying the image pixels directly [18]. But in frequently domain methods the image is transferred into frequently domain. In another word, the Fourier transform of the image is computed first. This paper tries to introduce an efficient approach for medical image enhancement. This approach based on the filter response generation. Gaussian and average filters are proposed to implement in this work.

2. LITERATURE REVIEW

A. Imgae Enhancement Techniques

First, There are many techniques have been developed to extend the spectrum range of human visual sensing, which is a powerful and meaning full in many type of image enhancement such as commercial, medical, rescue field and military. Infrared image system it allow people to detect heat and dark sources without extra illumination. This system used in night driving for car and airplane, fire detection in forest, surveillances system and weapon sitting [29][30][31][32][33]. Contrast enhancement (CE) is a critical picture preparing strategy for both human perception and Computer vision. It is generally utilized for restorative image processing [34], video observation framework [35], breaking down pictures from satellites [36], haze expulsion in clever transportation system [37], and so forth. Various difference upgrade systems have been proposed lately. For the most part, these procedures can be extensively characterized into two classes: direct enhancement improvement techniques [38] and indirect enhancement improvement strategies [39]. In direct enhancement strategies, differentiate is communicated by some pre-characterized contrast measurements, at that point comparing calculations are contrived to enhance these estimations; On the other hand, indirect enhancement techniques endeavor to enhance contrast by redistributing the likelihood thickness without characterizing a particular differentiate terms [39]. Indirect improvement techniques pull in the most analysts because of their adequacy furthermore, instinctive execution characteristics [33][39], and they can be additionally separated into two groups:

group 1) transform domain techniques (e.g., logarithmic processing, power-law processing, Piecewise linear processing, gray-level slicing, etc.) [40].

and group 2) histogram transformation techniques (e.g., histogram specification (HS), histogram equalization (HE),histogram modification, etc.) [41]. Among different difference improvement strategies, histogram preparing methods get the most consideration. Histogram detail, (additionally called histogram coordinating) is a sort of histogram handling procedure that alters the first information histogram to complete the coveted histogram change work. Normal appropriations for the coveted yield histogram are uniform, Gaussian, what's more, exponential ones. To get the coveted shape, one must have a precise priori learning, which is relatively inconceivable for a few applications, since common pictures display essentially distinctive histogram attributes starting with one then onto the next [42]. HE is the most ordinarily utilized histogram preparing system. In any case, this procedure frequently bombs in creating agreeable outcomes for certain class of pictures. There are essentially three sorts of distortion: excessive brightness change/brilliance immersion, commotion ancient rarities [43], and losing of subtle elements. To overcome these shortcomings, a gathering of specialists introduced their enhanced HE-based techniques. Brilliance saving bi-histogram adjustment (BBHE) [44] was the most punctual work on keeping original input brightness in the output image. Gamma remedy techniques1, which were created initially to adjust for the input/output normal for cathode beam tube shows, make up a group of general HM techniques. In a strategy called weighted threshold histogram evening out (WTHE) exhibited in [45], the information histogram was altered by weighting and thresholding before HE was connected. The WTHE can offer some controllability of the complexity improvement. Notwithstanding, it produces ancient rarities on a few pictures with slope histogram spikes [46].There are likewise offbeat procedures to the histogram-based complexity upgrade problem. In a strategy called Gray-level gathering (GLG) [47], the info histogram containers are arranged

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into 75 some sub-bunches as indicated by a chose foundation; at that point these sub-bunches are iteratively redistributed consistently finished the grayscale; lastly, these assembled receptacles are ungrouped. In spite of the fact that GLG can change the level of improvement and can adequately deal with histogram spikes, it is essentially intended for still pictures, since it has high calculation unpredictability and can't deal with the most irritating issue in video upgrade of glinting [48]. During consultations with medicinal services experts, patients are much of the time given extensive measures of data [49], which can be imperative to settle on educated choices about treatment. Nonetheless, existing writing has discovered that comprehension of medicinal data can be poor. Research has demonstrated that pictures including pictures, graphs and 2D pictures may help patient understanding [50] [51] and increment patient fulfillment [52]. In any case, they may likewise cause anxiety [53]. Late advances in innovation have permitted the improvement of 3D medicinal pictures, reproduced from the computerized information of 2D checks. 3D pictures can be turned for a survey from various points and may profit lay gatherings of people as organs and structures are effectively identifiable. The writing proposes there is enthusiasm for the particular capability of 3D pictures to have more prominent utility in speaking with patients, in that capacity pictures are thought to be less demanding to comprehend [53]. However, it may, at an exhibit, examine the advantages of demonstrating 3D pictures to individuals who don't have medicinal preparing is meager.

An important target of an upgrade is to process a picture with the goal that it has a superior introduction than the first picture for a particular application. The picture upgrade calculation utilized relies on the target to be accomplished and additionally the application. For case, a technique that is very valuable to improve X-beam pictures may not be the best approach to improve pictures of Mars transmitted by a space test. Despite the technique utilized, picture improvement is a standout amongst the most fascinating and outwardly engaging zones of picture preparing. Picture upgrade falls into two general classes: spatial space and recurrence area. The term spatial space alludes to the picture plane, and methodologies in this class depend on coordinate control of pixels in a picture. Recurrence space handling procedures depend on altering the Fourier change of a picture. Upgrade procedures in light of different mixes of techniques from these two classifications are most certainly not bizarre. There is no known general hypothesis of picture improvement. At the point when a picture is handled for visual elucidation, the watcher is a definitive judge of how well a technique functions. The visual assessment of picture quality is profoundly subjective. The meaning of a "decent picture" turns into a tricky standard used to assess calculation execution. At the point when the issue is the preparing pictures for machine recognition, this assessment undertaking is to some degree less demanding. For case, in a character acknowledgement application, and not considering different issues, for example, computational necessities, the best picture handling strategy would be the one that yields the best machine acknowledgement comes about. Be that as it may, even in circumstances when a reasonable basis of 39 executions can be forced on the issue, a specific measure of experimentation generally is required before any picture improvement approach is chosen.

B. Cardiac Catheterization

An angiogram is an X-beam test that uses a unique color and camera to take photos of the bloodstream in conduit, (for example, the aorta) or vein, for example, the vena cava. An angiogram can be utilized to take a gander at the corridors or veins in the cerebrum, arms, heart, leg, back or on the other hand midsection. A coronary angiogram is a system that utilizations X-beam imaging to see heart's veins. The test is generally done to see whether there is a confinement for bloodstream to the heart. A coronary angiogram is a piece of a general gathering of techniques known as heart catheterization. Cardiovascular catheterization methodology can analyze and regard heart and also vein conditions. A coronary angiogram is the most widely recognized kind of heart catheterization method. Amid a coronary angiogram, a kind of radio-murky color that is obvious by an X-beam machine is infused into the veins of the human heart. The X-beam machine quickly takes a progression of pictures (clinical angiograms), offering a glance at the veins Angiography is the highest quality level method used to assess irregularities or at statement happened in veins, giving pictures great spatial and transient determination. In advanced pictures, the picture handling filtration methods can be effortlessly utilized. The most straightforward strategies incorporate the thresholding and the histogram activities which suggest human intercession. The programmed approaches are hard to execute because of various vessel scales and organ shadows [54]. The Gabor channel utilizes the directionally specific band pass channels which are effectively connected for orientated line identification. The multistage form offers a probability to be adjusted for various frequencies. By tuning these channel frequencies, the clamor is wiped out and the vessel centerline is upgraded, making the strategy perfect for the low balance pictures with an obscuring foundation. The capability of genuine Gabor filter part arranged in the point ϕ,

$\phi = -\Pi/2$ is g(x,y) ;

$$g(x,y) = \frac{1}{2\Pi SxSy}\exp\left\{-\frac{1}{2}\left[\left(\frac{x}{Sx}\right)^2 + \left(\frac{y}{Sy}\right)^2\right]\right\}.COS(2\Pi\vartheta x)$$

Where ϑ is the focal spatial recurrence, Sx and Sy control the spatial expending on a level horizontally and vertically identified with recurrence and the introduction band, Sx/Sy is the angle proportion that is a measure of the channel's asymmetry [55].

C. Image processing algorithm

Image edge is an imperative function over image, which contains ample interior information, certain namely direction, step characteristics, shape yet etc, consequently it has been extensively used in image segmentation, photo categorization, image registration, and sample cognizance [56]. The side mostly exists within aim yet object, objective then background, area or area. Edge discovery is viewed as like an important research about that domain then a large quantity on researches has been conducted, typical the advance discipline differential operator such so Roberts operator, Prewitt operator, then Sobel operator yet 2nd rule differential driver certain as Laplace leader and LOG operator. In 1986, Canny proposed the area discovery operator based about optimization algorithm yet the 3 strictest criteria because of part detection consequently far. The tremendously simple algorithm makes the complete system remain correctly executed and has been widely old [57]. But the traditional CANNY operator has the error that animal vulnerable after a variety of noise Disturbances, hence there are absolute obstacles on its concrete application. For this above problems, quite number researches have been conducted out and many enchantment measures have been proposed. Thorough deeply gaining knowledge of previous works, this bill proposes an multiplied algorithm, among which self-adaptive filter is old in imitation of exchange the Gaussian filter and morphological thinning is adopted to slight the edge, the improved algorithm improves the legibility on the detection. As the area yet the confusion each are excessive frequency signal.

This bill proposes the adaptive filter rather the Gaussian filter, which perform pick the weight adaptively according the jump services on the ripe values on the image, yet at the same time, sharpening the facet concerning the image.

The Canny part detector algorithm is carried out on MATLAB Simulink 2013a. The capable part detector is chronic for finding edges regarding object present into the enter image. The Simulink mannequin because able edge detector is depicted in the Fig. 3, indicates its input-output images with Histogram or PSNR analysis blocks.

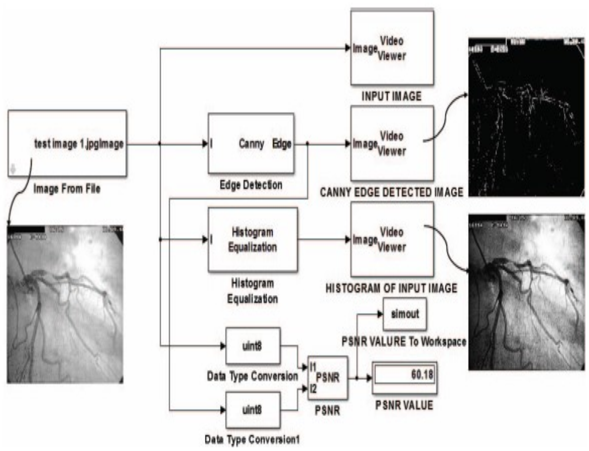

Figure 31 Canny edge detector (Simulink model)

Image segmentation is an important technique for most medical picture evaluation tasks. Having good segmentations desire gain clinicians and patients so they furnish necessary statistics because 3D visualization, surgical dodge and quickly disorder detection. The climacteric segmentation method has been widely ancient within clinical picture segmentation. Examples include the assignment into [43], [44] as fulfill use of the watershed radically change in imitation of segment gray yet white matter from magnetic resonance (MR) images. The algorithm born beyond mathematical morphology that deals together with the topographic representation about an image [45], [46]. The set on pixels including the lowest regional catholicity corresponds after the regional minimum. The minima of a picture are the groups of connected pixels along their grey level exactly lower than their local neighboring pixels. The rainfall simulation [47] describes as when rain fountain onto the surface, some cloud decline reaching a point within the surface will waft alongside its steepest descent till that reaches a minimum. The paths of pixels, who converge towards a common minimum, represent a catchment basin. Watersheds are the classy areas as part the different catchment basins. The partitions, which we aim in accordance with obtain, are the catchment basins, and the boundaries within the partitions are the watersheds. Advantages about the climacteric seriously change encompass the fact so much such is a fast, easy then intuitive method. More importantly, it is able in imitation of outturn a fulfilled division of the picture within separated regions too proviso the contrast is poor, as a result there is no want in conformity with raise out any post processing work, certain namely contour joining. Its drawbacks desire consist of over-segmentation and sensitivity to clamor [57].There has additionally been an increasing hobby in applying smooth segmentation algorithms, where a pixel may stay classified partly into multiple classes, for MR photos segmentation [58], [59], [60]. The fuzzy C means clustering algorithm (FCM) is a soft segmentation method to that amount has been ancient extensively for segmentation over MR photos [61]. However, its main disadvantages consist of its computational complexity and the fact so much the performance degrades extensively along accelerated noise. K-means clustering algorithm [62], [63], concerning the mean hand, is a simple clustering approach with paltry computational complexity as compared to FCM. The clusters best by using K-means clustering operate no longer overlap. In it work, we use K-means clustering to produce a principal segmentation over the photo earlier than we apply the accelerated point segmentation algorithm, which we proposed within an previously employment [63], according to the primary segmentation.

D. Cardiac catheterization techniques

Cardiovascular catheterization will be a technique used to diagnose and treat cardiovascular states. Throughout cardiovascular catheterization, a in length slim tube called An catheter is embedded in an conduit or vein in patient groin, neck alternately arm Furthermore strung through your blood vessels should your heart.
In order to perform the Cardiac catheterization there are some techniques should be followed as follow:

1- Patient preparation
The risks and side effects that will be infected from Cardiac catheterization should be explained to the Patients.
The most common complications are access site haematoma, vagal reaction, pneumothorax and arrhythmias. Where, available individual or departmental complication rates should be quoted [64].

2- Pressure Tracings
It is critical to make verify that pressure lines and transducers are correctly set up, as any inaccuracies in measurement will be magnified in subsequent calculations. During procedure the patient must have ECG monitoring, this to ensuring the pressure and ECG traces are timed correctly [65].

3- CO measurement

There are some methods that will be used to allocate the CO measurement but most commonly used techniques are the Fick and Thermodilution methods.

Thermodilution measurements involve injecting a fluid bolus at a known temperature into the proximal port of a PA catheter, and recording the change in temperature at the distal end of the catheter with a thermistor. CO is calculated based on the temperature and specific gravity of blood, and the temperature, specific gravity and volume of injected fluid [65].

The Fick method for determining CO requires the following measurements [65].

- Oxygen consumption or VO2
- The oxygen content of arterial blood
- The oxygen content of mixed venous blood

The Fick method requires measurement of oxygen consumption during cardiac catheterization using a spirometer and rebreathing bag, which is time-consuming and often impractical.

E. In which case the Cardiac Ctheterization is Rquired:

In general cardiac catheterization will be done when a doctor has conviction that there may be a blockage in one or more of coronary arteries of patient's heart.

The symptoms that will be represented as indicators of having heart problem are vertigo, shortness of breath, Chest pain, and extreme tiredness.

There are some difference reasons that will motivate the doctors to perform Cardiac catheterization such as:

- Evaluate heart muscle function.
- Evaluate or confirm the presence of heart disease
- Heart valve disease
- Congenital heart disease.
- Heart failure.

F. The Stages of Cardiac catheterization procedure

1- Patient preparation

At this step the Patient will need to fast, depending on Patient's situation such as age and chronic diseases. The doctor will tell the Patient how long to fast. The Patient will be asked to stop certain medicines before the procedure. The Patient will change into a hospital gown. An intravenous (IV) line will be started in Patient's arm. The Patient's bladder should be empty. And finally the Patient will meet the doctor to explain the test side effect, answering the Patient questions and to sign a consent form [66].

2- During the procedure

a-The Patient will lie on his/her back on the procedure table and the access site will be cleaned with antiseptic.

b- An ECG device monitor will be connected to the Patient's body which the role of this device is to record the electrical activity of the heart.

c- The site will be injected with a local anesthetic and once the local anesthetic has taken effect, the doctor inserts a sheath, or introducer into the blood vessel. This is a plastic tube through which the catheter is thread into the blood vessel and advanced into the heart. If the arm is used, the doctor may make a small incision (cut) to expose the blood vessel and put in the sheath. Then, a small amount of dye is injected into each coronary artery. This dye makes the arteries easy to see on x-ray[66].

When the dye is injected, the Patient may:

• have a metallic taste in his/her mouth

• feel a warm flush sensation like he/she have wet the bed.

d- If a closure device is used, a sterile dressing will be out over the site. If manual pressure is used, the doctor (or an assistant) will hold pressure on the site so that a clot will form. Once the bleeding has stopped, a very tight bandage will be placed on the site.

3- Beyond the Procedure

a- Beyond the cardiac catheterization, the Patient will be returned to his/her room. Deliberation/ sense in the affected leg or arm and vital signs of patients will be monitored by a Nurse. And the sheath will be removed by a nurse. And then a pressure will be applied for 15 to 30 minutes to stop the bleeding.

b- After a period of time the patient is allowed to have a light meal and drinks. This may cause the patient to pass more urine than usual.

c- The patient will be asked to stay in bed for up to 2 hours or the Nurse will gives this recommend based on the patient situation [66].

G. Side Effect and Risks Of Cardiac Catheterization

cardiac catheterization can cause complications, both vascular access complications and complications from closure of the arteriotomy incision. like any invasive procedure, accessing the heart through the femoral artery has risks. In

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2% to 10% of cases, complications such as bleeding, thrombotic complications, endovascular trauma occur as it showed in table 1[67]

Table 1 Complications Of Formal Artery Access During Cardiac Catheterization [67]

Complication	Cause	Clinical findings
Vessel laceration	Puncture or laceration of femoral artery	Secondary complications from bleeding: hematoma, retroperitoneal hemorrhage, pseudoaneursym, arteriovenous fistula
Hematoma	Bleeding into groin or thigh	Hard palpable swelling at the access site Variation in size: small, <1 cm; medium, 1-5 cm; large >5 cm Pain in groin area
Retroperitoneal hemorrhage	Bleeding behind the serous membrane lining the walls of the abdominal and pelvic cavities	Hypovolumia, hypotension, decreased hematocrit that may require blood transfusion, flank pain (diagnosed by using computed tomography)
Pseudoaneurysm	Commonly a puncture of one of the weaker walls of the branch of the femoral artery, causing bleeding in the tissue surrounding the artery via a small tract and forming a wall around the artery	Painful pulsatile mass, new bruit, groin pain or burning, swelling at groin site (confirmed by using ultrasonography)
Arteriovenous fistula	Puncture of the artery and vein causing a tract to form and allowing direct communication between them	Usually asymptomatic, high-output congestive heart failure, palpable thrill, audible bruit (confirmed by using ultrasonography)
Acute vessel closure/thrombus	Embolized thrombus from catheter Thrombus from dissection flap	Leg: paresthesia, pain, pallor, pulseless, cold
Neural damage	Femoral nerve injury during access Retroperitoneal hematoma or pseudoaneursym hematoma causing compression of lumbar plexus Femoral hematoma causing nerve compression	Pain, tingling at groin site, numbness at site or down leg, difficulty moving leg, leg weakness, decreased patellar tendon reflex
Infection	Foreign body administration, compromised sterile technique, prolonged in-dwelling sheath time, hygiene	Pain, erythema, fever, swelling, purulent drainage at access point

The each of female sex, hypertension, age, bleeding and obesity will be represented as factors to occur vascular complications.

Risks are rare but can include:

- Bleeding around the point of puncture
- Abnormal heart rhythms
- Blood clots
- Infection
- Allergic reaction to the dye
- Stroke
- Perforation of a blood vessel

3. METHOGOLOGY

H. Image Dataset

Many heart Catheterization video are collected from different patients. These videos are recorded with a duration time about 30 milliseconds. These videos are extracted into frames to be ready for processing. These frames (images) are organized into set of groups depends on the quality of images with image size (512*512) (fig. 4).

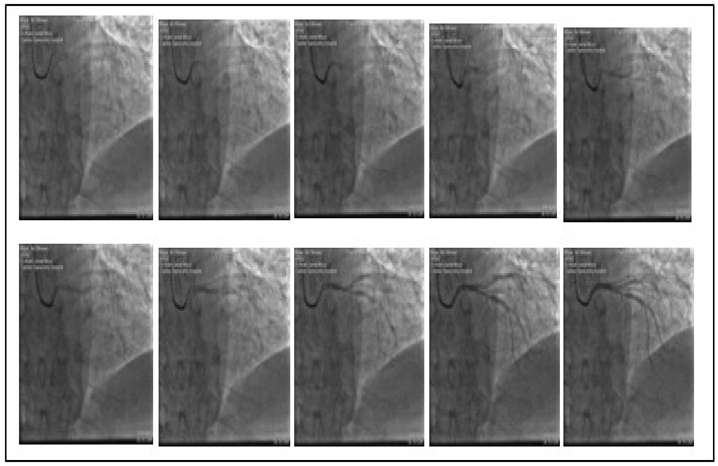


Figure 4 Image Dataset

I. Implemented System

Define Image enhancement is an important issue of image processing. This approach is concentrated on medical image enhancement, this part of processing needs high level of enhancement to improve the image quality as possible. Quality of medical image leading doctors to improve their diagnosis and decisions.

The proposed approach is divided into five steps (fig. 5).

1. Image Acquisition: In this step converting the real part of the human body into images. Heart Catheterization achieve Catheterization video and this related to both diagnostic and intervention. The Catheterization video is extracted into frames to be processed.
2. Image Preprocessing: The extracted frames are preprocessed to reduce the unwonted noise as possible. This step in implemented via median filter to avoid any degradation in image.
3. Converting Color into Gray Image: In this step, if the image is in color space, it is important to convert it into grayscale image to be ready for processing. Let this image is represented as x(i,j).
4. Filter Response Generation: this step is the most important part in which the impulse response of the filter is generated according to the required specification. Two types of filters Gaussian and Average are used in this approach. Let this impulse response is represented as h(i,j).
5. Image Enhancement: this step is implemented via the convolution process

between the impulse response and the image to generate the enhanced image.

y(i,j) = x(i,j) * h(i,j)

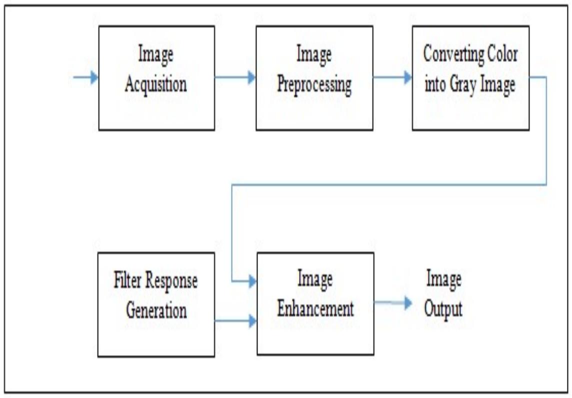


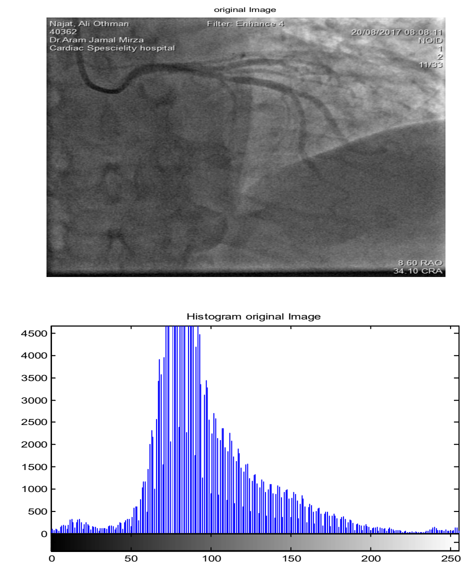
Figure 5 Medical Image Enhancement Approach

II. RESULTS AND ANALYSIS

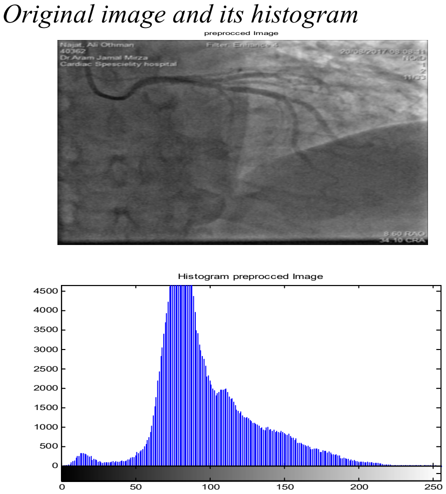
In this approach it is important to calculate the image quality of the enhanced image compared with the original image. The Structural Similarity Index for measuring image quality is implemented in this approach to measure both similarity values in each pixel in addition to the average value between pixels.

The Catheterization video is extracted into frames, these frames are processed to enhance the image quality. To achieve the enhancement, the similarity of image quality is measured in each step of processing. The impulse response of Gaussian and Average filters are generated with different filter sizes are tested to find the best filter adequate for medical image enhancement.

To explain the results in an adequate form, this approach shows both image display and histogram display to recognize the quality improvement in each step. Fig. 6 shows the enhancement of image approach using Gaussian filter. Fig. 6a shows the original image and its histogram. Fig. 6b shows the preprocessed image and its histogram. Fig. 6c shows the enhanced image and its histogram. Fig. 6d shows the equalized image and its histogram. According to these results, applying Gaussian filter leading to good improvement and the Structural Similarity Index is around 0.8297.



(a) Original image and its histogram



(b) preprocessed image and its histogram

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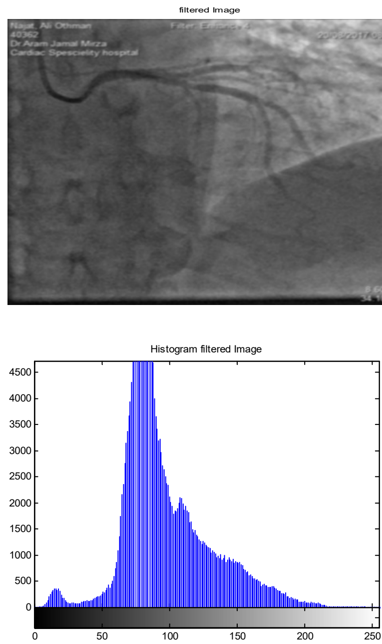
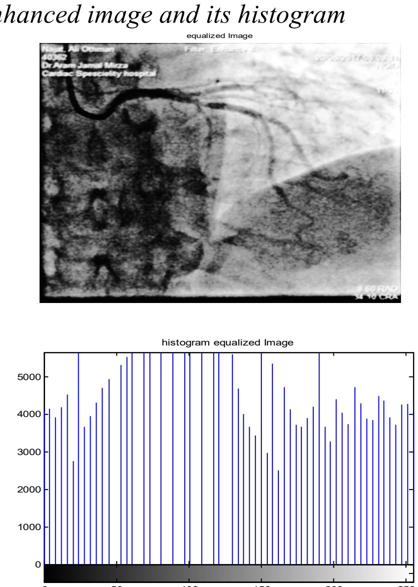


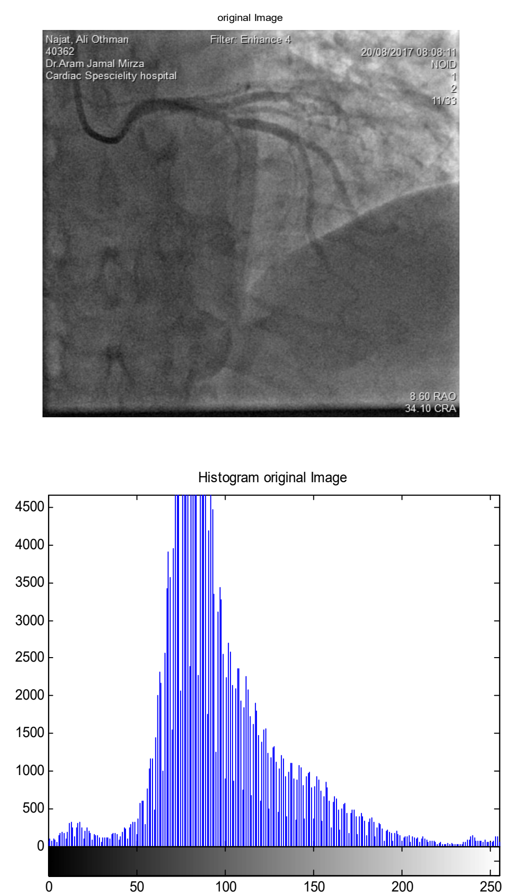
(c) enhanced image and its histogram



(d) equalized image and its histogram
Figure 6 applying the enhancement on image using Gaussian filter

Figure 7 shows the enhancement of image approach using Average filter. Fig. 7a shows the original image and its histogram. Fig. 7b shows the preprocessed image and its histogram. Fig. 7c shows the enhanced image and its histogram. Fig. 7d shows the equalized image and its histogram. According to these results, applying Gaussian filter leading to good improvement and the Structural Similarity Index is around 0.7079.

	Gaussian Filter				Average Filter			
Image number	Filter size 3*3	Filter size 5*5	Filter size 7*7	Filter size 9*9	Filter size 3*3	Filter size 5*5	Filter size 7*7	Filter size 9*9
Image 1	0.8306	0.8300	0.8300	0.8300	0.7976	0.7163	0.6707	0.6502
Image 2	0.8277	0.8269	0.8269	0.8269	0.7942	0.7117	0.6657	0.6454
Image 3	0.8341	0.8334	0.8334	0.8334	0.8020	0.7226	0.6781	0.6582
Image 4	0.8275	0.8268	0.8268	0.8268	0.7939	0.7110	0.6649	0.6446
Image 5	0.8309	0.8303	0.8303	0.8303	0.7978	0.7161	0.6707	0.6512
Image 6	0.8350	0.8343	0.8343	0.8343	0.8026	0.7234	0.6799	0.6612
Image 7	0.8233	0.8227	0.8227	0.8227	0.7885	0.7031	0.6557	0.6347
Image 8	0.8283	0.8277	0.8277	0.8277	0.7949	0.7128	0.6679	0.6480
Image 9	0.8346	0.8339	0.8339	0.8339	0.8025	0.7233	0.6786	0.6582
Image 10	0.8302	0.8296	0.8296	0.8296	0.7967	0.7135	0.6656	0.6431



(a) Original image and its histogram

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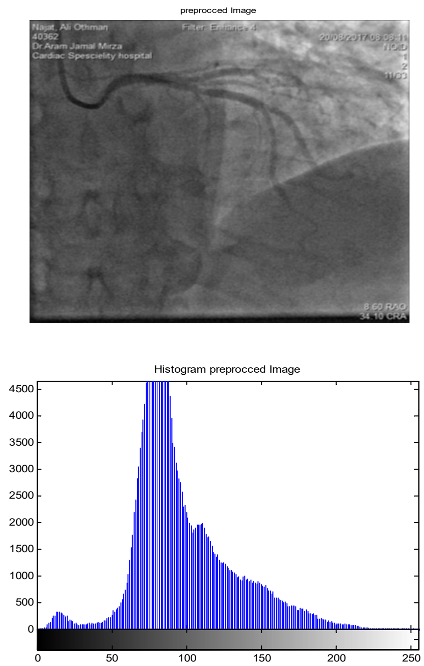
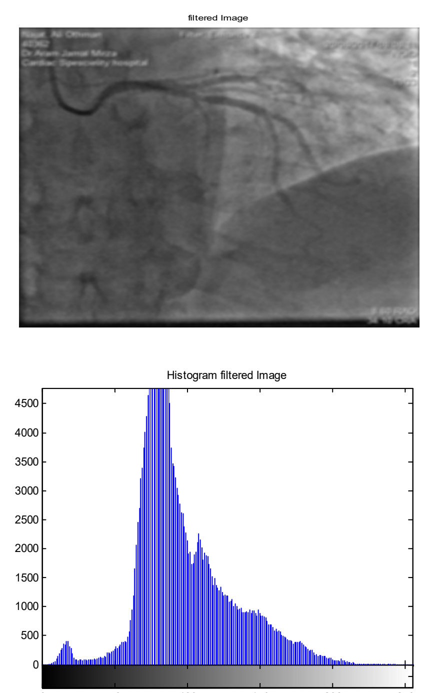
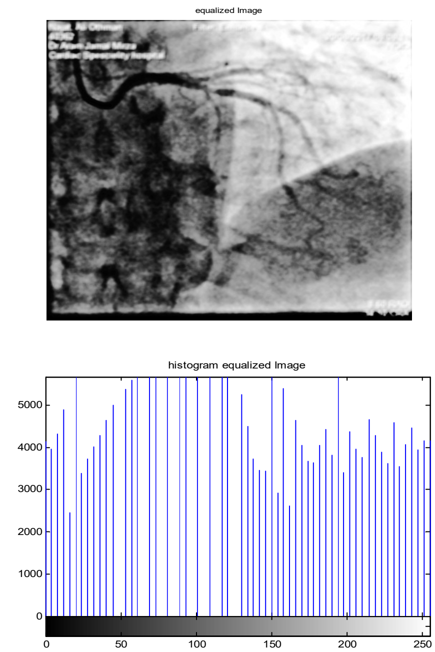


(b) preprocessed image and its histogram



(c) enhanced image and its histogram



(d) equalized image and its histogram

Figure 7 applying the enhancement on image using Average filter.

Table 2 and fig. 8 shown the Structural Similarity Index values for both Gaussian and Average filters with different filter size 3*3, 5*5, 7*7 and 9*9. These results indicated that applying Gaussian filter achieved good quality improvement value about 0.8297. In this case, varying the filter size has no significant change with the improvement.

On the other hand applying Average filter achieved good quality improvement value about 0.7079. In this case, varying the filter size has significant change with the improvement, where increasing the filter size reduces the quality improvement value.

The obtained result and the analysis are applied via Structural Similarity Index values in which gives similar values for Gaussian filter in all applied sizes. On the other hand we have small difference in the average filter, and the value will be reduced according to the increment in the widow size.

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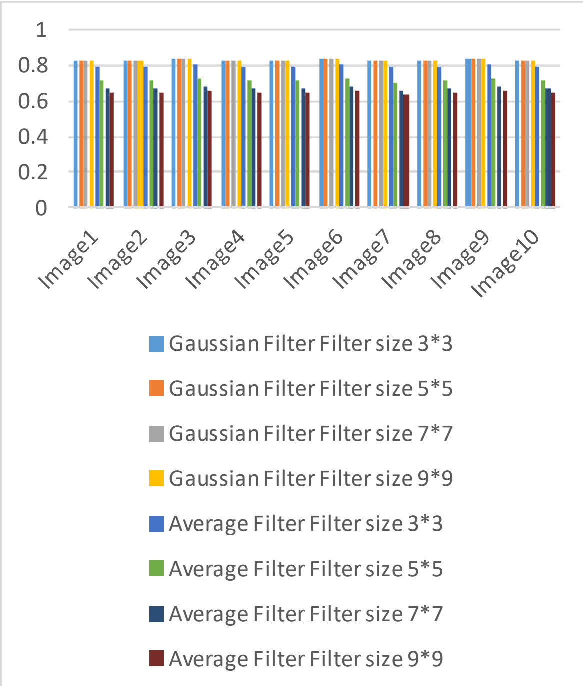

Figure 8 Structural Similarity Index Values

4. CONCLUSIONS

The heart catheterization in the past has been very complicated and needs many preparations. Now, cardiac catheterization is a simple test performed by the patient to ensure the safety of heart and heart arteries. The techniques have developed especially in the field of medical and diagnostic, as for cardiac catheterization, the most important is to detect places of blockages and constrictions, which can cause great harm to the patient. One of the problems that may occur at work is that some images are unclear and difficult to diagnose. The focus of this research is on how to improve the features of the image so as to be clear to the doctor. Two types of filters (Gaussian and Average) were applied and then the results were compared for both types. The Gaussian filter showed better results in improving the image parameters. Accurate results are obtained via applying Gaussian filter compared with that results obtained via applying average filter. In this work, there is no limitation excluding that related to low resolution or high noisy images.

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