3D VISUALIZATION BASED ON SURFACE ESTIMATION TECHNIQUES

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ABSTRACT

Three Dimensional (3D) image visualization is one of the important processes that extract information from a given single image. A robust algorithm is proposed to estimate the surface rendering of a single-view image. Firstly, the angiography image is enhanced and then conduct the segmented image into partitioning process in which the image is divided into homogeneous regions using adaptive K-mean algorithm, based on color of gray scale level. The goal of 3D image visualization is to formulate and realize concepts of an efficient architecture for productive use of medical image data. The proposed method is easy to use as well as it can be implemented on various type of angiography images. The obtained results indicate a good resolution of the 3D reconstruction process.

KEYWORDS: *3D visualization, 3D imaging, surface rendering, volume rendering, medical imaging.*

I. INTRODUCTION

The development in medical imaging technology have made it possible routinely to acquire high-resolution, three dimensional (3D) images visualization of human anatomy and function using a variety of medical imaging modalities. Today, most medical imaging modalities generate digital images, which can be easily manipulated by digital computers. The use of 3D image processing and visualization techniques makes direct inspection of the scene in three dimensions visualization feasible and greatly facilitates the extraction of quantitative information from the medical images.

In this work we try to explain the concepts and methods of 3D visualization, in addition a robust algorithm is presented to perform reconstruction of 3D three dimension image visualization.

II. LITERATURE REVIEW

The field of 3D medical image visualization is an important aspect of medical image processing, because of their huge applications in many areas of our live special in the medical diseases diagnosis. Many articles and Literature Review are published in this field and we will explain some of these works.

Jiyo.S.Athertya et al. (2012) presented a method for Reconstruction three dimension models using two dimension image slices of CT add to the uniqueness while picturing the internal details of the organ. The objective of this paper is to develop an algorithm for stacking the 2D slices to create a 3D output for image guided surgeries. This aims at increasing the operation accuracy and safety during computer aided medical procedures. One such is the spinal fusion processes where only a marginal error is allowed. The rendered output provides a better graphic user interface in aiding physicians. The model of spinal column is mainly reconstructed for identifyingScoliosis, Spondylolisthesis, pondylolysis and other vertebral deformations [1].

Nina Olamaei et al. (2012) presented an algorithm for 3D reconstruction of a microvascular network. To evaluate the algorithm, magnetic microparticles were released in an unknown simulated microvascular network. The microparticles were scanned in different slices and at time intervals equal to the temporal resolution of the system. By recording the X, Y, and Z coordinates of the particles, points were generated to reconstruct their travel trajectory through the different bifurcations. The results show that the measurement errors for reconstructed networks using 30 ìm and 15 ìm particles are ~0.4 mm (smaller than one pixel image) and ~0.28 mm (more than half pixel image), respectively.The proposed method provides promising accuracy in 3D reconstruction of the micro vasculature using susceptibility artifact in simulated images of a clinical MR scanner. However, the method should be validated by real-time MR images of magnetic microparticles released in a microvascular network [2].

Hua Zhong et al. (2012) in this paper an automatic heart segmentation system for helping the diagnosis of the coronary artery diseases (CAD) has been presented. The goal is to visualize the heart from a cardiac CT image with pulmonary veins, pulmonary arteries and left atrial appendage removed so that doctors can clearly see major coronary artery trees, aorta and bypass arteries if exist. The system combines model-based detection framwork with data-driven post-refinements to create voxel-based heart mask for the visualization. The marginal space learning algorithm is used to detect mesh or landmark models of different heart anatomies in the CT image. Guided by such detected models, local data-driven refinements are added to produce precise boundaries of the heart mask. The system is fully automatic and can process a 3D cardiac CT volume within 5 seconds [3].

Lu Xiaoqi et al. (2012) In this paper, Reconstruction 3D image is based on Interactive data language IDL programming language and development environment, adopting PolyPaint and Raycasting algorithm drawing component of IDL constructs three-dimensional (3D) image. Experimental results demonstrate that this reconstruction is fast and efficient, friendly interaction and convenient extension [4].

S´everine Habert et al. (2012) this paper presents a new application of the shape from silhouette (SFS) method for the 3D reconstruction of coronary arteries with Kawasaki disease from angiographic images. The silhouettes of the arteries were first segmented from the angiographic images using the Frangi filter followed by thresholding then a morphologic erosion step. Finally, a volume-based reconstruction approach was performed to infer the visual hull representing the 3D volume of the segmented arteries. The proposed method was first validated on simulated data to determine the optimal number of views that provide a 3D reconstruction with an adequate precision. The sensitivity of the proposed method to calibration errors was also evaluated. Furthermore, a clinical evaluation on four patients with Kawasaki disease showed that using three views in addition to the standard AP and LAT views does not improve the accuracy of the 3D reconstruction. Therefore, this study showed that an online 3D reconstruction of the coronary arteries, requiring less than one minute, during the acquisition could help to rationalize the number of views required for the 3D assessment of aneurysms [5].

A. Bardera et al. (2009) present a novel information-theoretic approach for thresholding-based segmentation that uses the excess entropy to measure the structural information of a 2D or 3D image and to locate the optimal threshold. The main motivation of this approach is the uses of excess entropy as a measure of structural information of an image. Experimental results have shown a good behavior of the implemented approach [6].

K. Kerchetova et al. (2008) provide the construction of 3D images based upon various medical data that trained by computer tomography, magnetic resonance imaging, scintigraphy …etc. This work describes an approach of 3D model reconstruction from medical images by using detailed initial information obtained for forming DICOM files. The proposed system describes methods to provide practical improvements to the reliability of medical diagnostics [7].

Nicolas Herlambang et al. (2008) present a real time autostereoscopic visualization system using the principle of integral videography. The system was used to visualize 4D MR image that was generated from registration of 3D MR image and 4D ultrasonic image. The evaluation of processing speed showed that GPU processing time was faster than CPU processing time for integral videography volume processing [8].

Qi Zhang et al. (2007) implement a new segment-based post color-attenuated classification algorithm to address the problem of interactive 3D medical image visualization. An efficient numerical integration computation technique is applied to take the advantage of the symmetric storage format of the color lookup table generation matrix. This algorithm will facilitate the interactive visualization of the medical image database in both diagnostic and therapeutic applications [9].

Meisam Aliroteh and Tim McInerney (2007) present fast and accurate interactive segmentation method for extracting and visualizing a large range of objects from 3D medical images. This model is simply and precisely initialized with a few quick sketch lines drawn across the width of the target object on several key slices of the volume image [10].

III. 2D IMAGE VISUALIZATION

Typically 3D medical image data are stacks of 2D images. Radiologists and nuclear medicine physicians are trained to provide their diagnosis based on these 2D images. These images show the anatomy or function of thin slices through the body and are mostly acquired directly from the imaging system. The orientation of these slices is defined by the constraints of the imaging modality. However, it is quite easy to calculate slices of a different orientation from the original stack of images by simple interpolation. This re-slicing process is known as multi-planar reformatting (MPR). Curved slices are also useful but less common than planar re-slices. Figure (1) the centerline of the main coronary arteries is automatically found and a curved slice through each of these arteries can be shown **(a)**. Analysis of the coronary arteries. The computer automatically delineates the main arteries, the myocardial and heart chambers and a 3D image of the delineated structures can be shown **(b)**. The centerline can be stretched and re-slices along or perpendicular to the centerline of the blood vessel can then be visualized **(c)**. Due to the recent advances in multimodal acquisition systems (e.g., PET-CT) and 3D image visualization software, corresponding multimodal or multi-temporal images can be visualized together [11].

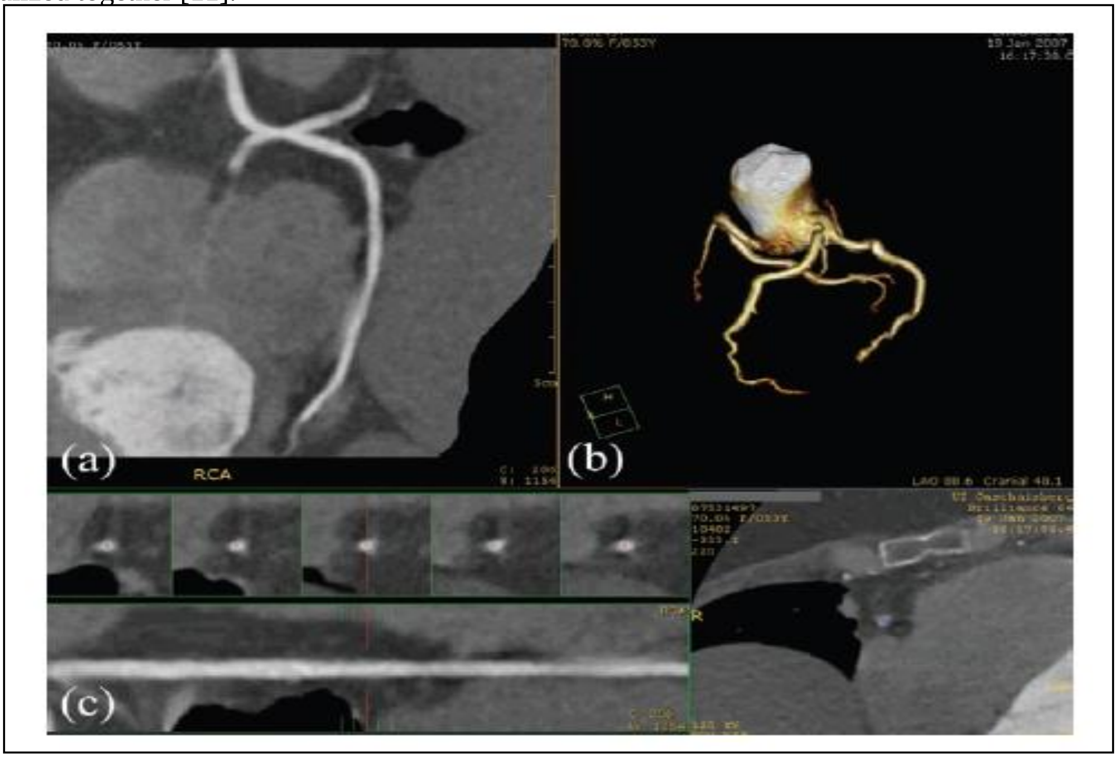

Figure (1) curved slice through one of the main coronary arteries

IV. 3D IMAGE VISUALIZATION

The presentation of 2D medical imaging depends on the physical orientation of the image plane with respect to the structure of interest see the Figure (1) (c). Most medical imaging systems have limited capabilities to create optimal 2D images directly. Many techniques are used to generate 2D images from 3D objects, and these techniques depend on the extraction of the important fractures [12].
Varity of methods and systems are developed for 3D medical image display and visualization, these methods normally are divided into two major techniques: indirect volume rendering (IVR), sometimes called surface rendering (SR) and direct volume rendering (DVR) see Figure (1) (b). Both techniques

produce the visualization of 3D volume images, and each has its advantages and disadvantages. The selection between these methods depends on the application and the result of the 3D visualization.

V. INDIRECT VOLUME RENDERING TECHNIQUES

Surface rendering (SR) or (IVR) is a common method of displaying 3D images. Visualizing surfaces extracted from volumetric image data requires object segmentation. Nevertheless 3D surface visualization has become common practice today in medical imaging. A 3D surface is described by its geometry and its reflection and transmission properties, including its intrinsic color pattern or texture [13]. Surface rendering algorithm sometime called indirect volume rendering is the same volume rendering expect that it draw the surface with highlights from a color of gray scale level of the object. The surface rendering is create surface defined by four matrix arguments (X, Y, Z, C) plots the colored parametric surface. The axis labels are determined by the range of X, Y, Z, or by the current setting of axis. The color scaling is determined by the range of C, or by the current setting of Caxias. The scaled color values are used as indices into the current color map. The surface normalization algorithm returns the components of 3D surface normal for the surface with components (X, Y, Z). The normal is normalized to length 1. The surface normalization plots the surface with the normal emanating from it. The surface normal returned are based on bicubic fit of the data. The advantage of this technique speeding up the processing because of minimum volumetric data required for create surface. Also this technique can take advantage of particular graphics hardware to speed the geometric transformation of surface rendering operations. The disadvantages of this technique based on the data required for building 3D surface, some image information is lost in this process. so we must select good segmentation algorithm for segmenting object from background without lose necessary information about the object, Also this method eliminates any interactive dynamic construction of the surface to be rendered.

VI. DIRECT VOLUME RENDERING

Direct Volume Rendering (DVR) is an efficient technique to explore complex anatomical structures within volumetric medical data. Real-time DVR of clinical datasets needs efficient data structures, algorithms, parallelization, and hardware acceleration [13]. DVR displays the entire 3D dataset by tracing rays through the volume and projecting onto a 2D image, without computing any intermediate geometry representations. This algorithm can be further divided into image-space DVR, such as GPU-based raycasting, and object-space DVR, such as splatting, shell rendering, TM, and cell projection. Shear-warp can be considered as a combination of these two categories. In addition, MIP, minimum intensity projection (MinIP), and X-ray projection are also widely used methods for displaying 3D medical images [13,14].

VII. THE PROPOSED VISUALIZATION ALGORITHM

This proposed algorithm of 3D image visualization is used to generate 3D image depending on the object extraction from background, then the algorithm can be implemented in the following steps as shown in figure (2):

- Image acquisition.
- Image enhancement.
- Image segmentation.
- Calculate surface estimation
- Surface rendering algorithm.
- Surface normalization algorithm.

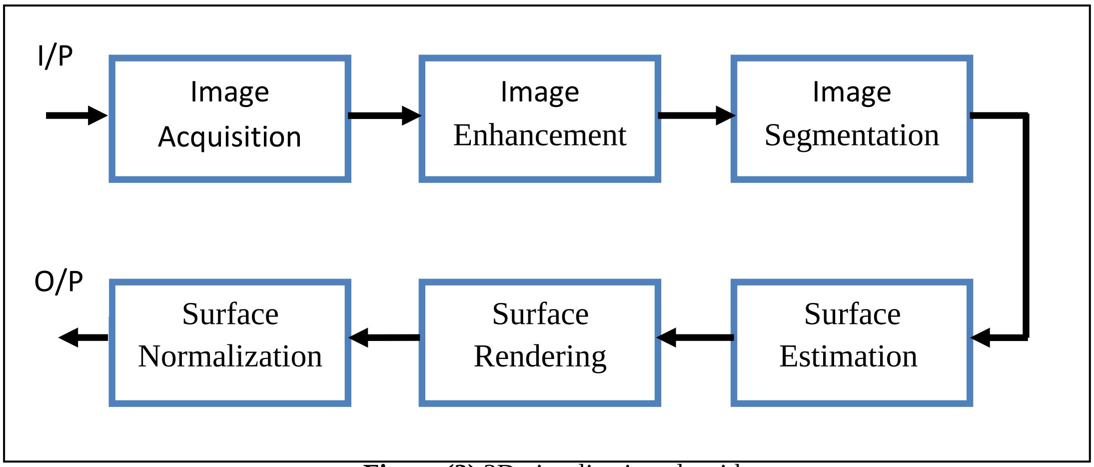

Figure (2) 3D visualization algorithm steps

VIII. RESULTS AND ANALYSIS

The implementation of the proposed system is done on various collected data from different patients. Applying histogram process is very important to inform us about the characteristics of the image in which we know the distribution of pixels over the overall image as shown in figure (3).

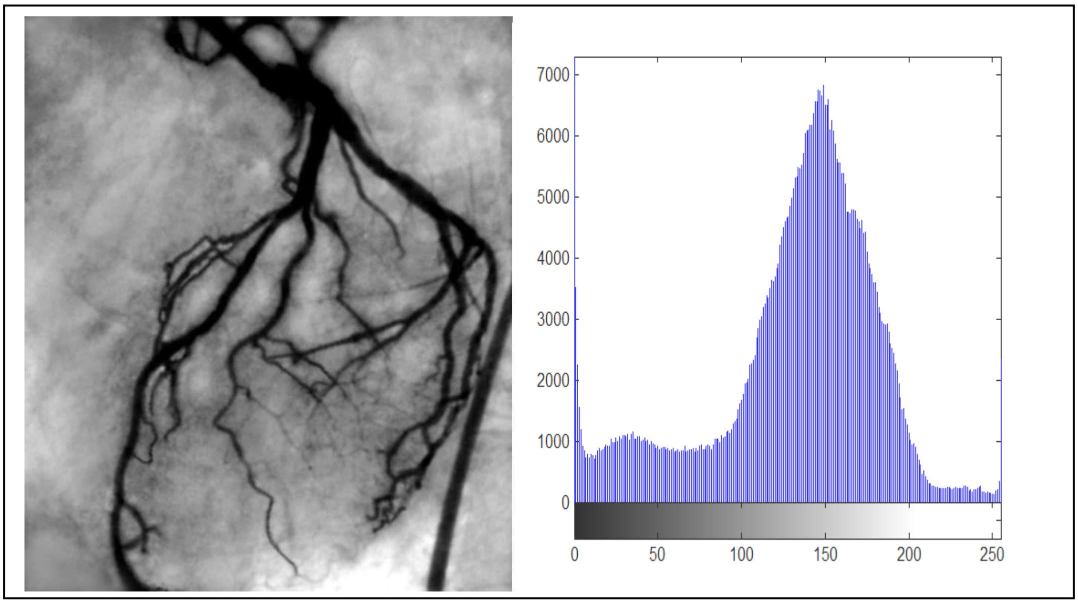

Figure (3) original image and its histogram

The following figure (4) shows the original image, enhancement image, segmentation image, surface rendering image and the visualization image. These figures illustrate the obtained results, starting from the original medical image, passing to all of the algorithm steps, reaching to the final step.

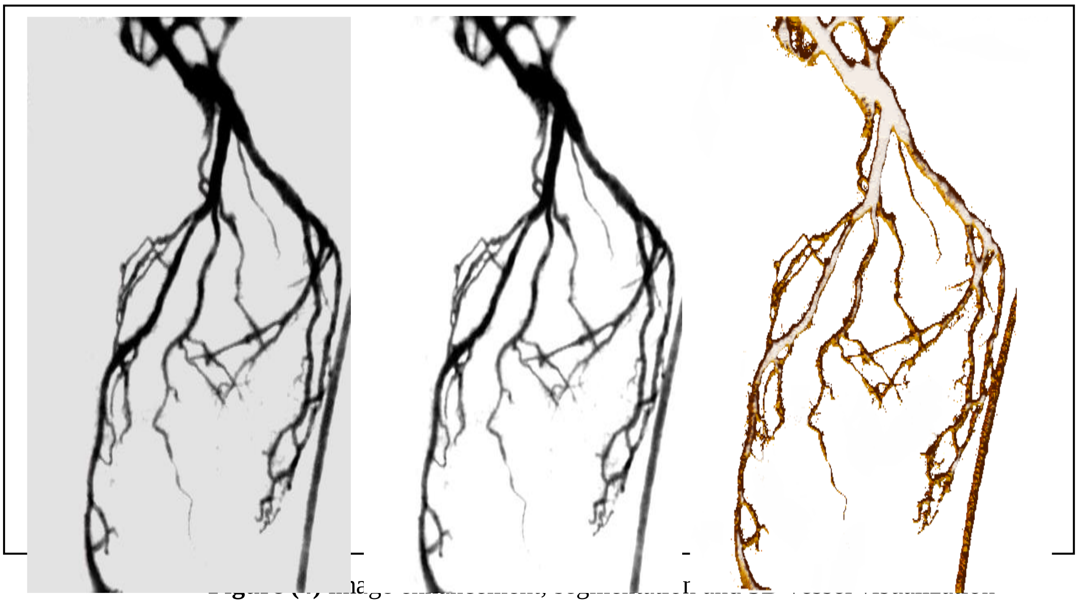

Figure (7) image enhancement, segmentation and 3D vessel visualization

IX. CONCLUSION AND FUTURE WORK

Medical angiography imaging deals with many problems such as low resolution, high level of noise, low contrast and geometric deformations. Surface estimation technique is an effective method for 3D image reconstruction. Surface estimation techniques is implemented on single image to construct 3D image graphic representation, which is an important issue that open wide fields of applications. This paper presents a robust proposed algorithm for 3D visualization via the extraction of the 3D image from 2D image. The obtained results indicates that a good resolution of the 3D reconstruction process. This algorithm is implemented on medical images and also it supports different forms of image format.

The suggestion could be implemented in the future to make the project more optimal is using virtual endoscopy instead of visualization where virtual endoscopy is a novel display method for three dimensional medical imaging data. It produce endoscope-like displays of the interior of hollow anatomic structure such as airways and blood vessels.

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