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Concept of Image Processing in Implementation of Aortic Valve Stent

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Abstract

Heart disease is the leading cause of death in the world. Heart disease is generally happed due to blockage of Arteries for that Balloon angioplasty is used, it improves necessary blood-flow by inserting a balloon into the affected artery and inflating it in order to compress any plaque present and prop open the artery. One of the solutions for that is coronary stenting. Stent is tube like geometry and have mesh structure that allows expansion. It can be self expanding or expanded by means of an inflatable balloon. Stenting can be employed following angioplasty in order to prevent the re-narrowing of an artery, or stenting can be performed in one step, in which the artery is opened and the stent is implanted an image processing is having important role in stent implementation provide the interface between the operator and patient. The analysis of geometric (deformation) error of the stent implementation can be easily analyses by image processing in the field of bio medical.

Keywords: *Biomedical image processing, stent implementation, geometric errors like deformation*

INTRODUCTION

The heart is a muscular organ that functions as the body's circulatory pump. It takes in deoxygenated blood through the veins and delivers it to the lungs for oxygenation before pumping it into the various arteries. Coronary artery disease is also called atherosclerotic heart disease in which excess cholesterol attaches itself to the walls of coronary artery vessels. As an atherosclerotic plaque increases in size, the insides of the coronary arteries get narrower and less blood can flow through them, usually resulting in myocardial infarction or heart attack [1, 2].

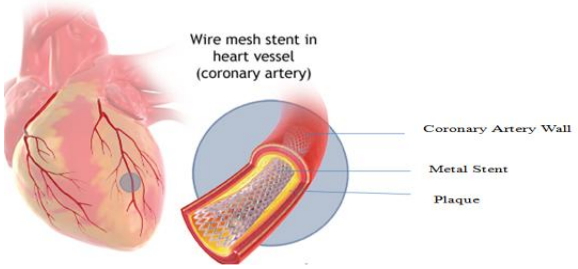

Fig. 1: *Representation of Stent.*

Coronary artery bypass graft by surgery Graft (CABG) is a surgical method in which one or more blocked coronary arteries are bypassed a blood vessel graft to restore normal blood flow to the heart [3, 4]. These grafts usually come from the patient's own a rteriesand veins located in the limbs or chest. Among the popular interventional treatments on coronary heart diseases, the

stent implantation prevails as a new typical therapy due to its little pain to the body and excellent effectiveness [3].

In surgery, percutaneous pertains to any procedure wherever access to internal organs or alternative tissue is completed via needle-insertion of the skin, instead of by victimization associate "open" approach wherever internal organs or tissue area unit exposed. This approach is often employed in vascular procedures like surgical procedure and stenting. In general, percutaneous refers to the access modality of a procedure, whereby a medical device is introduced into a patient's vas via a needle stick. The technique involves inserting a needle through the skin and into a vas, like associate artery or vein, till bleed back is achieved. This is followed by introduction of a versatile "introducer guide wire" to outline the pathway through the skin and into the passageway of the vessel. The introducer guide wire is removed, and changed for a tubing or different medical device to be wont to deliver medication or implantation of a medical implant like a filter or a tube into the vessel. the benefits of a percutaneous access is within the simple penetrating the devices into the patient while not the employment of enormous cut downs, which might be painful and in some cases can bleed out or become infected. A percutaneous access needs solely a really little hole through the skin that seals simply, and heals terribly quickly compared to a surgical block.

Coronary or cardiac stents are used in surgical procedures called percutaneous transluminal coronary angioplasty (PTCA), also known as balloon angioplasty [1]. These procedures are intended to reduce the risk of heart attacks or other complications stemming from coronary heart disease that involves the blockage of the arteries. In a PTCA, a catheter is inserted through an artery in the leg and drawn into the area of the blockage. The artery is opened with a balloon, and a stent is often used to maintain the opening and prevent the artery from reclosing is called restenosis [5, 6]. An intraluminal coronary artery stent is a small, self-expanding, metal mesh tube. It is placed within an arterial {blood vessel} when balloon surgical process to forestall the artery from re-closing. A tube may be a little tube placed into associate artery, blood vessel, or different hollow structure in your body (such because the tube that carries urine) to carry it open. Once a tube is placed into the body, the procedure is termed stenting. A tube designed to be inserted into a vessel or passageway to stay it open. Stents area unit inserted into narrowed coronary arteries to assist keep them open when balloon surgical process. The tube then permits the conventional flow of blood and atomic number 8 to the center. Stents also are employed in different structures like the passage to treat a constriction, the utters to keep up the evacuation of water from the kidneys, and, therefore, the canal to stay it open.

TYPES OF STENTS

There are different kinds of stents. Most are made of a metal or plastic mesh-like material. However, stent grafts are made of fabric. They are used in larger arteries.

Drug-Eluting Stent

A drug-eluting stent is coated with a medicine that helps further prevent the arteries from narrowing of a blood vessel. Like other coronary artery stents, it is Located permanently in the artery [5].

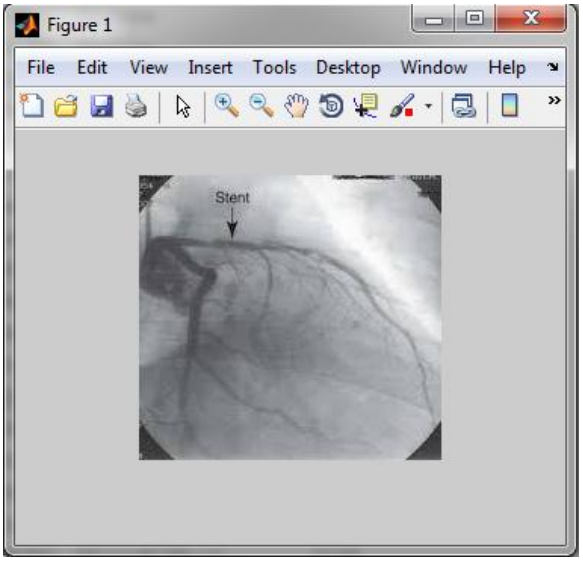

Fig. 2: *Drug-Eluting Stent.*

Bioabsorbable Stent

A bioabsorbable or perishable tube bioabsorbable tube might be constituted within the patient in order that, by the time the tube totally degrades, Thus, bioabsorbable stents appear to be a viable various to permanent coronary stents, your time we tend to might replace permanent tube with perishable tube and it will not build any form of damage to build [5].

Metal Stent

Coronary stents are made up with different types of metallic material such as, albeit made from the Cr-Ni-Mo steel belong to the long-term implants. Investigations are also ongoing on using the amorphous silicon carbide (a-SiC: H) as a coating for the coronary stents [1]. Metallic stents can induce late thrombosis and thickening of the inner lining of the artery as a response to arterial wall injury (Thrombosis is the formation of a blood clot inside a blood vessel).

WHY THE PROCEDURE IS PERFORMED

Most of the time, stents are used when arteries become narrow or blocked. Stents are commonly used to treat the following conditions that result from blocked or damaged blood vessels:

- Coronary Heart Disease.
- Peripheral Artery Disease.
- Renal Artery Stenosis.
- Abdominal Aortic Aneurysm.
- Carotid Artery Disease.

Other reasons to use stents include: Keeping open a blocked or damaged ureter (percutaneous urinary procedures) Treating aneurysms, including thoracic aortic aneurysms.

BIOMEDICAL IMAGE PROCESSING

Biomedical image processing has experienced dramatic expansion, and has been enter disciplinary research field attracting expertise from applied mathematics, computer sciences, engineering, statistics, physics, biology and medicine. The principal objectives of this course are to provide an introduction to basic concepts and techniques for medical image processing and to promote interests for further study and research in medical imaging processing. In addition, various image processing tools allow for interesting sensitivity analyses to be carried out implementation of Aortic Valve stent [6].

Medical Imaging

Imaging technology in Medicine made the doctors to see the interior portions of the body for easy diagnosis and to understand

human physiological system. It also helped doctors to make keyhole surgeries for reaching the interior parts of internal organs without really opening too much of the body. CT scanner, Ultrasound and Magnetic Resonance Imaging (MRI) took over x-ray imaging by making the doctors to look at the body's elusive third dimension (3D view). With the CT scanner, body's interior can be bared with ease and the diseased areas can be identified without causing either discomfort or pain to the patient. Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to image the anatomy and the physiological processes of the body in both health and disease. MRI scanners use strong magnetic fields, radio waves, and field gradients to form images of the body MRI picks up signals from the body's magnetic particles spinning to its magnetic tune and with the help of its powerful computer, converts scanner data into revealing pictures of internal organs. Image processing techniques developed for analyzing remote sensing data may be modified to analyze the outputs of medical imaging systems to get best advantage to analyze symptoms of the patients with ease.

Principles of Computer Tomography (Ct)

Computerized Axial Tomography or computer transmission tomography or computer tomography is a method of forming images from X-rays. Computed tomography (CT scanning) is a medical imaging modality where tomo graphic images or slices of specific areas of the body are obtained from a large series of two-dimensional X-ray images taken in different directions, These cross-sectional images can be combined into a three-dimensional image of the inside of the body and used for diagnostic and therapeutic purposes in various medical disciplines. Measurements are taken from X-rays transmitted through the body. These contain information on the constituents of the body in the path of the X-ray beam. The high voltage d.c. power supply drives an X-ray tube that can be mechanically rotated along the circumference of a gantry. The patient lies in a tube through the center of the gantry. The X-rays pass through the patient and are partially absorbed. The remaining X-ray photons impinge upon several radiation detectors fixed around the circumference of the gantry. The detector response is directly related to the number of photons impinging on it and hence to the tissue density. The output unit then produces a visual image of a transverse plane cross-section of the patient on the cathode ray tube. These images are also stored into computer for image processing [7].

Principles of Magnetic Resonance Imaging (MRI)

What is MRI? Briefly, Magnetic resonance imaging (MRI) of the body uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of the inside of your body. It is a tomographic imaging technique that produces images of internal physical and chemical characteristics of an object from externally measured nuclear magnetic resonance (NMR) signals. During the past few decades, MRI use for imaging tools toward ever more reliable detection and diagnosis of disease. The magnetic field gradient system normally consists of three orthogonal gradient coils, Gx, Gy and Gz, essential for signal localization. The gradient field strength is usually less than 1 G/cm. MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body

structures. MRI does not use ionizing radiation (x-rays). The RF system consists of a transmitter coil that is capable of generating a rotating magnetic field, referred to as the B1 field, for exciting a spin system, and a receiver coil that converts a processing magnetization into an electrical signal [6].

Methods of image analysis belong to a general interdisciplinary area of multidimensional signal processing; a different approach to image analysis is based upon the selection of appropriate features assigned to all individual image pixels. Values of a feature vector associated with each image pixel are evaluated from the root pixel neighbourhood of the selected shape and size. Image pixels can then be classified directly into the given number of levels in the case of the properly chosen set of feature vectors.

Watershed Transformation

The Watershed transformation is a powerful tool for image segmentation; it uses the region-based approach and searches for pixel and region similarities. A watershed segmentation used for image components detection. The watershed transform is able to detect most of image components even though the problem of fault class boundaries can arise in some cases. The proper segmentation is the fundamental task for further image analysis. The Watershed Transform (WT). It was introduced in 1979 by Beucher and Lantu´ejoul by analogy to the topography feature in geography. It can be explained intuitively in the following manner: consider a gray-level image to be a 3D topographical surface or terrain. A drop of water falling onto this surface would follow a descending path towards a local minimum of the terrain. The set of points, such that drops falling onto them would flow into the same minimum, is called a catchment basin. In the study of image processing a watershed of a grayscale image is analogous to the notion of a catchment basin of a height map. In short, a drop of water following the gradient of an image flows along a path to finally reach a local minimum. There are different technical definitions of a watershed. In graphs, watershed lines may be defined on the nodes, on the edges, or hybrid lines on both nodes and edges. There are also many different algorithms to compute watersheds. Watershed algorithm is used in image processing primarily for segmentation purpo ses. A watershed is a basin-like landform defined by highpoints and ridgelines that descend into lower elevations and stream valleys. Finally, the transform that takes an image as input and produces its set of watershed lines is called the Watershed Transform [7].

Pixel Selection

Pixel is that the smallest of an Image; therefore, it is the littlest governable part of an image described on the screen picture element choice is probably going the oldest segmentation methodology. It consists of choosing pixels alone supported their values and no matter their spatial neighbourhood. The best picture element choice methodology is humble thresholding, wherever, we have a tendency to choose pixels that have a gray-level price larger or smaller than some threshold price. The best thresholding strategies replace in a picture with a black picture element if the image intensity is a smaller amount than some mounted constant T, or a white picture element if the image intensity is bigger than that constant. Thresholding is the simplest method of image segmentation. This particular method is of course very crude,

but is used frequently. Multiple thresholding uses several values instead of a single value; color and multispectral thresholding using vectors of values and not just scalars. By definition all histogram-based methods for finding the parameters of the thresholding, including those that optimize a metric to achieve this, are pixel selection methods. Statistical methods (e.g., spectral classification methods) that include no spatial regularization fall into this category as well. This is, therefore, a veritable plethora of methods that we are including here, and research is still active in this domain. Of course, thresholding and related methods are usually very fast and easily made interactive, which is why they are still used so much. By properly pre-processing noisy, unevenly illuminated images, or by other transforms [8].

Random Walkers

In order to correct some of the problems inherent to graph cuts, Grady introduced the Random Walker (RW) in 2004.We set ourselves in the same framework as in the Graph Cuts case with a weighted graph, but we consider from the start a multi label problem, and, without loss of generality, we assume that the edge weights are all normalized between 0 and 1. This way, they represent the probability that a random particle may cross a particular edge to move from a vertex to a neighbouring one. Given a set of starting points on this graph for each label, the algorithm considers the probability for a particle moving freely and randomly on this weighted graph to reach any arbitrary unlabelled vertex in the graph before any other coming from the other labels. Eventually, the whole image is labelled with the object of interest consistently labelled with a single value.

CONCLUSION

Patient-specific analysis of the flow in coronary artery with a stent also involves computational challenges, mostly related to the need to have a good spatial representation of the stent. According to the previous discussions, the present work is directed toward a better understanding of coronary stenting biomedical image processing. With the help of biomedical image processing we can analyze geometric shape such as deformation of implemented stent. The principal objectives of this Paper are to provide an introduction to basic concepts and techniques for medical image processing and to promote interests for further study and research in medical imaging processing. In addition, various image processing tools as above discuss allow for interesting sensitivity and accuracy analyses to be carried out implementation of Aortic Valve stent.

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