COMPARATIVE ANALYSIS OF BIO-CAD TECHNIQUE AND CANNY EDGE DETECTION ALGORITHM FOR LUMBAR SPINE IMAGES USING FINITE ELEMENT METHOD

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Abstract— **The spinal column, more commonly called the backbone, is made up primarily of vertebrae discs, and the spinal cord. The vertebral column usually consists of 24 articulating vertebrae, and nine fused vertebrae in the sacrum and the coccyx. It is situated in the dorsal aspect of the torso, separated by intervertebral discs.The lumbar spine refers to the lower back, where the spine curves inward toward the abdomen. It starts about five or six inches below the shoulder blades, and connects with the thoracic spine at the top and extends downward to the sacral spine. The lumbar vertebrae are the largest segments of the movable part of the vertebral column, they are elected L1 to L5, starting at the top. Bio-CAD has been used to assist in Bio-Medical design and Modeling of images for analysis. In this work Bio-CAD technique along with Canny Edge detection algorithm has been proposed to model and analyze the spine images. To find the correct boundary in noisy image of spine is still a difficult one. The proposed Canny Edge Detection algorithm has been used to detect the boundaries of spine image from the noisy spine image. The performance of proposed technique has been compared. The results show that the proposed Bio-CAD technique performs well and produced the better optimal solution Canny Edge Detection algorithm. This method is robust for all kinds of noisy images without prior knowledge of other properties. The performance of the both techniques was analyzed by calculating the probability error and edge length.**

Index Terms— **Bio-CAD, Canny edge detection, Edge detection, Image segmentation, Spine image.**

I. INTRODUCTION

Finite element method is a numerical technique for finding approximate solutions to boundary value problems for differential equations. The key functions of the Human spine as a composite structure is to protect the spinal cord. Manual material handling operations are carried out in most industrial plants. It uses variational to minimize an error function and produce a stable solution. Analogous to the idea that connecting many tiny straight lines can approximate a larger circle, FEM encompasses all the methods for connecting many simple element equations over many small sub domains, named finite elements, to approximate a more complex equation over a larger domain. Each behaviour task poses unique trouble on the employee. However, workplaces can help employees to perform these tasks safely and easily by implementing and maintenance proper policies and procedures. The lumbar region which is one of the parts in the spine has played a vital role in the researches. The anatomy lumbar region, the lumbar spine, the back pain and their relationship are put together in literature. The further analysis of the spine under the aircraft ejection is made and this deals with the FEM modelling of the spine for aircraft injuries [1, 2]. The finite element analysis in the field of orthopaedics for the lumbar region [3] has also been explained with its uses. The evaluation and management of occupational low back disorders and back pains were studied. The movement of human by motor control and biomechanics [4, 5] are illustrated in various aspects. Such similar investigations are made on the spine disk and are reported. Till date, the motion segment of the spine consists of two parts of which one is a vertebrae and the other one a disc [6,7,8]. To explicate proper information from the images, a fundamental tool used is the Edge detection technology. This provides the outlines of an image and boundaries [9]. This also proves as a tool to remove the noises in the images to enhance the appearance. The magnitude and Edge length based algorithm called the Canny Edge detection algorithm has been proposed for pre-processing the boundary detection of the CT-scanned disk image of the spine. To detect the correct boundary in a noisy image is still difficult. Based on the evaluation the canny edge detection algorithm is used to detect the boundaries of spine disc image from the noisy CT scanned image produce a better result. The Fig.1 shows a 2D model of spine disc image and the Fig.2 gives a clear view of the same in 3D model. The vertebral body of each lumbar vertebra is large, wider from side to side than from front to back, and a little thicker in front than in back. It is flattened or slightly concave above and below, concave behind, and deeply constricted in front and at the sides. The Fig.3 illustrates the various spine disc disorders. And Fig. 4 represents the spine image, and

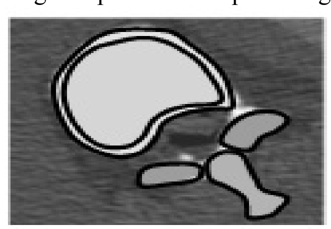

Fig.1. Spine Disc 2D Model

Table.1 gives the behaviours and properties of the spine. FEA consists of a computer model of a material or design that is stressed and analysed for exact results. It is used in new manufactured goods design, and existing product refinement.

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A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition.

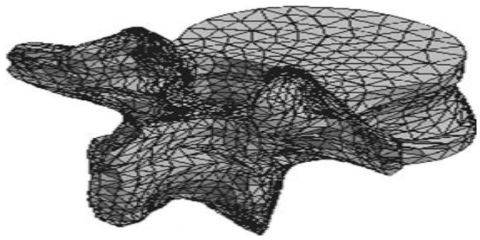

Fig.2. Spine Disc 3D Model

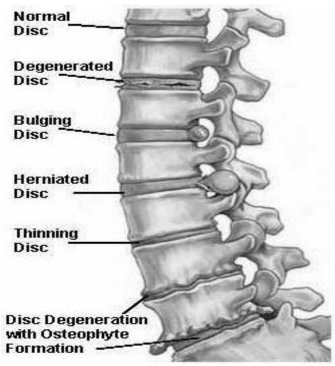

Fig. 3. Spine Disc disorders

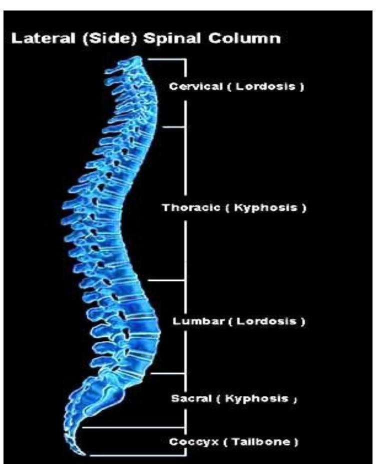

Fig.4 The Spine Image

Material	Young's Modules (Mpa)	Cross Section Area (mm^2)
Anterior Longitudinal	7.8	63.7
Posterior Longitudinal	10	20.0
Ligamentum Flavum	15	40.0
Transverse	10	3.60
Capsular	705	60.0
Interspinus	10	40.0
Superspinus	8	30.0
Iliolumbar	10	26.4

Table. 1. Spine Properties

S. No	Image illustration	Medical Standard Value (%)	Canny Edge Detection (%)	Bio-CAD (%)	Error Difference in Canny Edge	Error Difference in Canny Edge
1	CT Scan noisy spine disc image	8.51	8.56	8.52	+0.05	+0.01
2	Average magnitude image	7.73	7.78	7.76	+0.05	+0.03
3	Density of the Edge Length	7.00	7.07	7.01	+0.07	+ 0.01
4	Final Thresholding of edge map	6.44	6.35	6.34	-0.09	- 0.10
5	Initial Position map	5.90	5.97	5.97	+0.07	+0.07
6	Final Threshold Edge Map	5.07	5.15	5.12	+0.08	+0.03

Table 2.Comparison between BIO-CAD Technique and Canny Edge Detection Algorithm for CT Scan Lumbar Spine Disc Image.

II. PROPOSED WORKFLOW SEQUENCE

The Block diagram of the proposed system of Image segmentation technique is shown in Figure 5.The different process sequence is involved in this segmentation is given in below. The Original image is obtained from the CT scan image centre and then it will be in corporated by using Bio-CAD modeling and Image segmentation using canny edge detection algorithm.

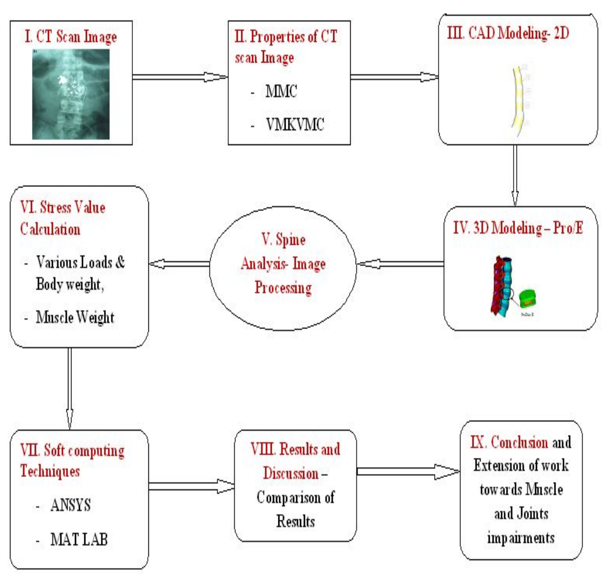

Fig.5 Work Flow Sequence

III. THE CANNY EDGE DETECTION ALGORITHM

The Canny algorithm can be used an optimal edge detector based on a set of criteria which include finding the most edges by minimizing the error rate, marking edges as closely as possible to the actual edges to maximize localization, and marking edges [10,11] only once when a single edge exists for minimal response. According to Canny

3.1 PRE-PROCESSING OF INITIAL POSITION OF EDGE PARAMETERS DETECTION

*Step1:*Calculate the average magnitude

$$M(1,2) = \frac{1}{M} \sum_{(1,2)}^{n} \sqrt{Mx(1,2)^2 + My(1,2)^2}$$

The optimal filter that meets all three criteria above can be efficiently approximated using the first derivative of a Gaussian function.

$$GF(i,j) = \frac{1}{2\pi\sigma^2} e^{\frac{i^2 + j^2}{2\pi\sigma^2}}$$

Step 2: Calculate the density of the edge length, The density of the edge length is calculated from

$$L(1,2) = \frac{C(1,2)}{\max C(1,2)}$$

Where C(i,j) is the number of connected pixels at each position of pixel.

Step 3: Calculate the Initial position of map from summation of density of edge Length and average magnitude.

$$P(1,2) = \frac{1}{2(M(1,2) + L(1,2))}$$

Step 4: Calculate the thresholding of the initial position map.

If $P(1,2) > T_{max}$

Then P(1, 2) is the initial position of the edge following. And then we obtained the initial position by setting T_{max} to 92% of the maximum value.

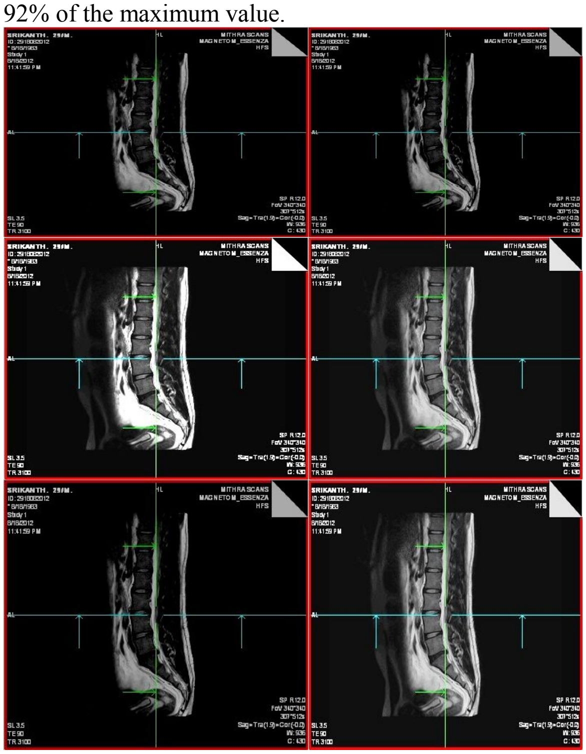

Fig.6. (a). CT scan Noisy Spine Disc image
(b). Average Magnitude Image.
(c). Density of the Edge Length
(d). Final Thresholding of edge map.
(e). Initial Position map,
(f). Final Threshold Edge Map

IV. CT SCAN SPINE IMAGE EDGE DETECTION USING BIO-CAD WITH FINITE ELEMENT METHOD

CAD has been used to assist and help in engineer image for design and analysis of images. And now CAD has been used for many advance and novel biomedical image applications ranging from Medical image modelling and analysis, clinical engineering and tissue engineering. Structure formation of Bio-CAD model for a Spine images from the noisy image data with the CAD modalities. It is known as Bio-CAD image modeling with Boundary values. With this technique we can able to predict the Boundary and edge of Spine image. Bio-CAD model of Spine image from the CT scan noisy images are shown in Fig. 7.

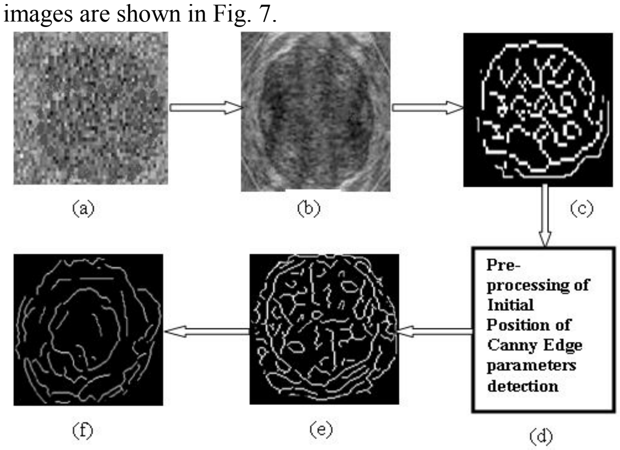

Fig.7.(a).CT scan Noisy Spine Disc image,
(b). Average Magnitude Image.
(c). Density of the Edge Length,
(d). Processing Sequence,
(e). Initial Position map,
(f).Final Threshold Edge Map.

V. RESULTS AND DISCUSSION

To further evaluate the efficiency of the proposed method in addition to the visual inspection, the proposed boundary detection method numerically using the Hausdorff distance and the probability of error in image segmentation. Where $P(O)$ and $P(B)$ are probabilities of objects and background in images. The objects surrounded by the contours obtained using the five snake models and the proposed method are compared with that manually drawn by skilled doctors from the Medical Hospital. From the above Table.2 shows the average result of probability of Error in Image segmentation of median filter and canny edge detection algorithm were compared with standard Medical values and also predicts the error difference. Showing the results it shows the Error difference value is very minimal and also negligible in median filter. So the Canny edge detection algorithm produced nearer to the standard value. Fig.8 Shows the comparative analysis of BIO-CAD and Medical standard value. Fig.9 Shows the comparative analysis Canny edge detection and the Medical standard value which is collected from the standard Hospital.

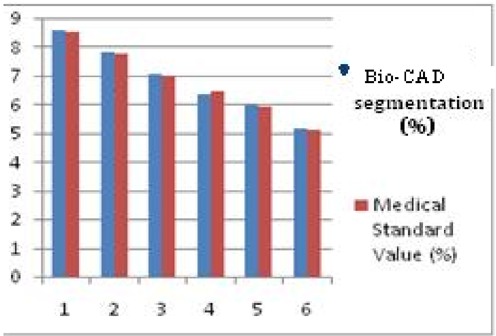

Fig 8. Comparative Analysis Graph for BIO-CAD and Medical Standard value.

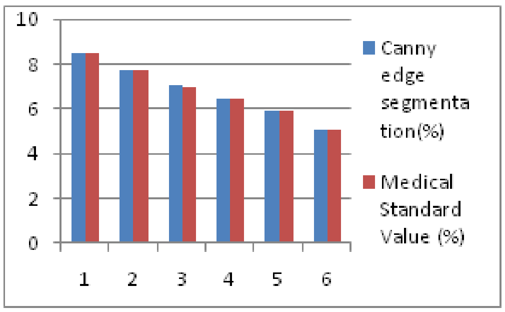

Fig 9. Comparative Analysis Graph for Canny Edge Detection value and Medical Standard value

CONCLUSION

The proposed technique for boundary detection and applied it to object segmentation problem in medical images. Our edge following technique incorporates a vector image model and the edge map information. The proposed technique was applied to detect the object boundaries in several types of noisy images where the well defined edges were encountered. Several synthetic noisy images were created and tested for the sake of the known ground truths. The opinions of the skilled doctors were used as the ground truths of interesting objects in different types of medical images including prostates in ultra-sound images of spine images. Besides the visual inspection, all methods were evaluated using the probability of error in image segmentation. The results of detecting the object boundaries in noisy images show that the proposed technique is much better. We have success-fully applied the edge following technique to detect the object boundaries in medical images. The proposed method can be applied not only for medical imaging, but can also be applied to any image processing problems.

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