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Development of an Image-Based Modelling Tool for the Spinal Deformity Detection Using Curve Fitting Technique

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***Abstract*— Scoliosis is a 3-dimensional abnormality of the spine that usually found in 2- 4% of adolescents population stated by the statistics of the country for scoliosis. Scoliosis is a disorder in which there is a sideways curve of the spine. Curves are often S-shaped or C-shaped. One of the methods to ascertain a patient with scoliosis is through using Cobb angle measurement. Any Cobb angle measurement takes about 20 – 30 minutes of inter and intra observer. Scoliosis prediction is of great significance to reduce the uncertainty for doctors on deciding the optimum treatment for patients. Therefore the importance of the automatic spinal curve detection system is to detect any spinal disorder quicker and faster. The challenging task in computerized method lies in totally automating the method of curvature measurement from digital X-ray images. The importance of the automatic spine curve detection system is to detect ant spinal disorder quicker and faster. The proposed research work uses a template matching based on Sum of Squared Difference (SSD) to estimate the location of vertebrae. By using polynomial curve fitting method, spinal curvature estimation can be done. In this paper, the performance of SSD used to detect a variety of data sources of X-ray from numerous patients. The results from the implementation indicate that the proposed algorithm can be used to detect all the X-ray images.**

Index Terms: - Cobb angle, Sum of Squared Difference (SSD), polynomial curve fitting method.

INTRODUCTION

The human spinal cord is a set of bones that supports the entire framework of the body. It gives the body its own shape and height. The spine consists of 33 bones, and these bones are made in series called “Vertebrae”. These vertebrae are constituted by discs and connective tissues which are connected to each other. From top to bottom these vertebrae are made up of different sections of the spine which corresponds to the curves. This section includes: Cervical spine(Neck vertebrae), Thoracic spine(Chest vertebrae),Lumbar spine(Lower back) and Sacrum and coccyx The vertebrae are totally different from each other, they are 7 Cervical,12 Thoracic,5 Lumbar,5 Sacral and 4 Coccyx vertebrae, as shown in Figure.1.s

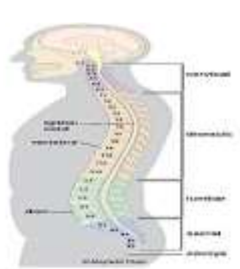

Fig.1: Spine Structure. Courtesy [Mayfield Clinic]

Scoliosis is a structural, lateral, rotated spinal deformity which is a multifactorial medical disorder in which a human spinal cord is curved from its original position to side to side, which requires multidisciplinary research and treatments. According to Clear Scoliosis institute[12] reports, the prevalence of scoliosis affected are 4 in 1000 adolescents, 8 to 10 patients visits hospitals for a month in India. In general populations 2% of women and 5% of men are affected by Scoliosis. Even though Scoliosis may be seen in different types, over 85% of scoliosis is Idiopathic Scoliosis, it can be also found in healthy peoples in which means that there is “No known cause”. Scoliosis is occurring equally on both genders, who are aged between 10 to 15 years old. 3 to 4 % of adolescents are found to have scoliosis in which the curves are more progressive which is 4 times faster for girls than boys. Scoliosis is mainly seen occurring in the following four regions as shown in figure.2.Thoracic region, Lumbar region, Thoracolumbar region and in both the lumbar and thoracic region, forming a double curve.

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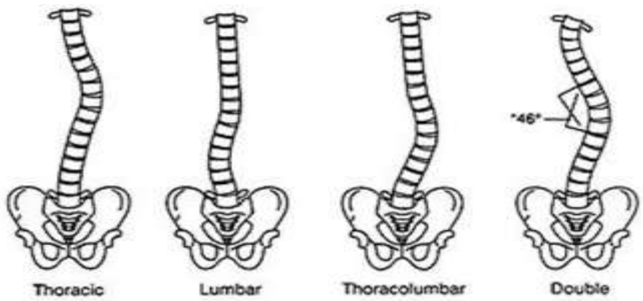

Fig.2: Curve Pattern of Spinal Cord. Courtesy [Hudson Valley of Scoliosis correction]

II LITERATURE SURVEY

"A Mask Based Segmentation Algorithm for Automatic Measurement of Cobb Angle from Scoliosis X-Ray Image" [1], Spinal deformity is a disorder in which there are different methods to sign a patient with scoliosis is through the measurement of Cobb angle. The importance of the Automatic detection of spinal curvature disorder should be faster and should consume less time. This paper proposes the highlights of using mask based x-ray image segmentation algorithm for measurement of Cobb angle with good accuracy. It also proposes the manual selection of Region of interest and also it is applicable only for C-shaped spinal curvature. "Spinal Curvature Determination from X-Ray Image using GVF Snake"[2], GVF Snake segmentation method is introduced in this paper to discuss about spinal deformity and pre-processing method it is employed with modified top-hat filter. Segmentation samples with are used by frontal spinal medical images with the parameter values of alpha=0.9, beta=0.5, and gamma=0.3 which fits well to the S-shaped spinal deformity using GVF Snake segmentation. The combination of disk sizes and attenuation factors of 1, 3, 5, 7 and 9 is used for pre-processing the image with the help of modified top-hat filter. Because of the low gradient difference, GVF (Gradient vector flow) snake couldn't detect any contour

"Spinal curvature Determination from Scoliosis X-ray Image Using Sum of Squared Difference Template matching 2016" [3], The spinal detection method that, the template matching sum of Squared Difference (SSD). This method is used to estimate the location of the vertebra. By using polynomial curve fitting, spinal curvature estimation can be done. This paper discusses the performance of SSD method used to detect a variety of data sources of X-Ray from numerous patients. The results from the implementation indicate that the proposed algorithm can be used to detect all the X-ray images. The best result in this experiment has 96.30% accuracy using 9-subdivisions poly 5 algorithms, and the average accuracy is 86.01%.

"Cobb Angle Quantification for Scoliosis Using Image Processing Techniques" [4], an appreciable measurement of spinal curvature using image processing methods in medical X-ray images, thus reducing human intervention. A new horizontal edge detection algorithm based on Gaussian first order derivative operation has been developed which is effective for the measurement of Cobb angle. The proposed computerized technique aims in reducing the user intervention using the input medical image to edge detection and obtaining gradient image which is then an application of thresholding and finally applying Hough transforms, the process helps in proper and easy assessment of spinal deformity.

III METHODOLOGY

The X-Ray images are preprocessed by using basic median filter to improve the contrast. Gaussian Filter is used to remove the salt and peered noise in the X-ray images. Then the resultant image is sharpened. A histogram of intensity is plotted along x and y axes to show the intensity mapping of the image. Curve fitting using polynomials of 6th order is used to trace the spine automatically. Then the Cobb angle is calculated using the regular method by drawing tangents. The block diagram of an automated module is shown if Figure.3

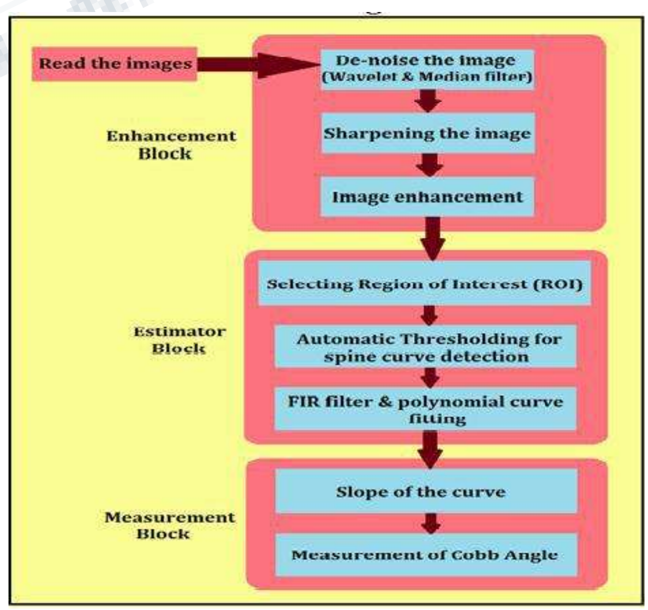

Fig.3: Block diagram of Automatic Cobb angle Estimator

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IV RESULTS

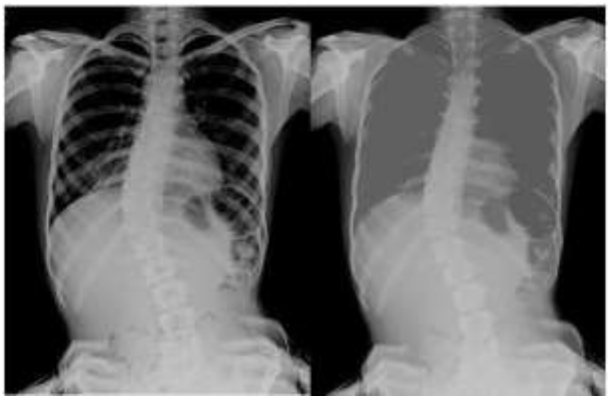

Fig.4.1: Original image and gray scale converted image

Fig.4.2: Black & White image to Median filtered image

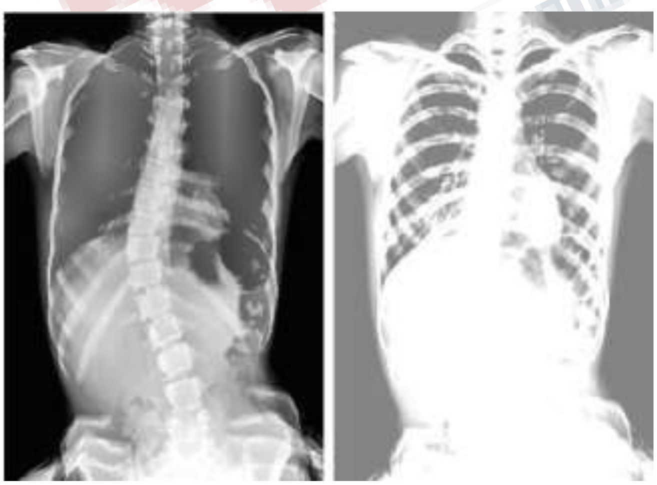

Fig.4.3: Median filtered image to Gaussian filtered image

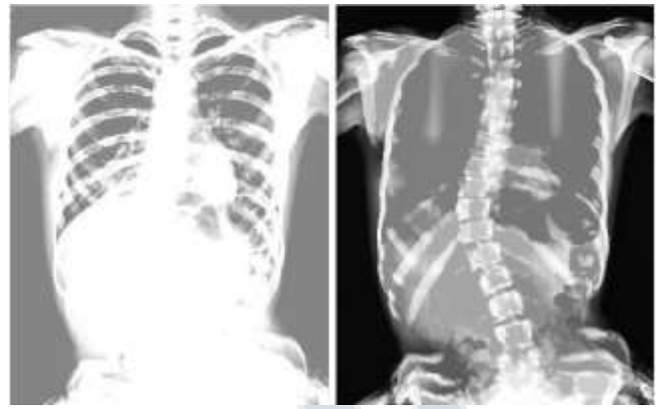

Fig.4.4: Gaussian filtered image to Sharpened image

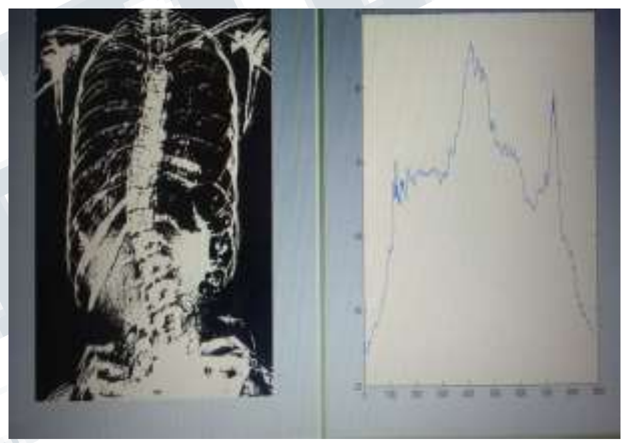

Fig.4.5:Intensity graph using histogram process along x axis

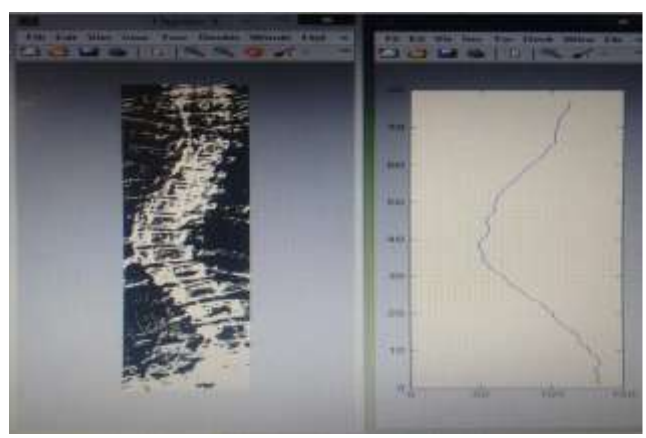

Fig.4.6:Intensity graph using histogram process along y axis

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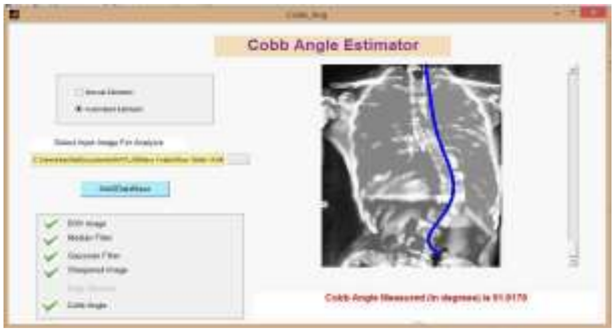

Fig.4.7:Automatic tracing of spine using polynomial curve fitting technique for patient1

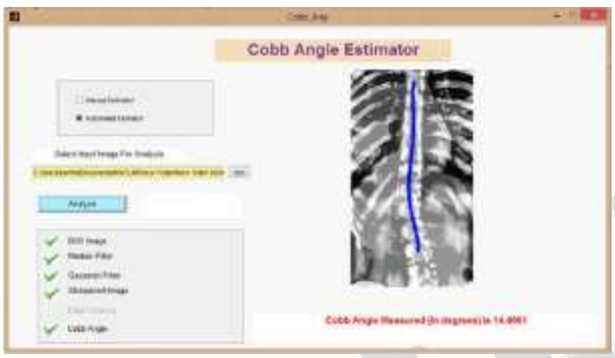

Fig.4.8: Automatic tracing of spine using polynomial curve fitting technique for patient1

The preprocessing results are shown in Figures 4.1 to 4.4.where the image in converted to gray scale. Median, Gaussian and sharpening filters are applied to get the sharpened image. Once the image is sharpened the histogram of intensity is plotted along both the axes as shown in Figure 4.5 and 4.6. The polynomial curve fitting techniques of order 6 is used to trace the line along the spine. The tracing of spine is shown for two patients in Figure 4.7 and 4.8.

Thus an attempt is made to trace the spine automatically and calculate the Cobb angle. The Cobb angles calculated by this automated module have to be compared with the values given by the spine surgeon and error has to be calculated to know the efficiency of the model.

REFERENCES

[1] Binoshi Samuvel, Vinu Thomas, Mini MG,"A Mask Based Segmentation Algorithm for Automatic Measurement of Cobb Angle from Scoliosis X-Ray Image." International Conference on Advances in Computing and Communications. 2012.

[2] Madha Christian Wibowo ,Tri Arief Sardjono, "Spinal Curvature Determination from X-Ray Image using GVF Snake", 2015 International Conference on Information, Communication Technology and System (ICTS).

[3] BagusAdhiKusuma, HanungAdiNugroho, SanuWibirama, "Spinal curvature Determination from Scoliosis X-ray Image Using Sum of Squared Difference Template Matching",2nd International Conference on Science and Technology-Computer (ICST), 2016.

[4] Raka Kundu, Prasanna Lenka, Ratnesh Kumar, Amlan Chakrabarti, "Cobb Angle Quantification for Scoliosis Using Image Processing Techniques", International Conference on Recent Advances and Future Trends in Information Technology (iRAFIT2012), Proceedings published in International Journal of Computer Applications® (IJCA) , Vol. 8, 2012.

[5] Rashmi, Mukesh Kumar, and Rohini Saxena, "Algorithm and Technique on various Edge Detection: A Survey Signal & Image Processing", International Journal (SIPIJ) Vol.4, No.3,June 2013.

[6] Raka Kundu, Prasanna Lenka, Amlan Chakrabarti," Cobb Angle Quantification for Scoliosis Using Image Processing Techniques" International Conference on Recent Advances and Future Trends in Information Technology (iRAFIT)2012.

[7] Tariq Abuzaghleh, Buket Barkana, "Computer-Aided Technique for the Measurement of the Cobb Angle", University of Bridgeport, Bridgeport, CT, USA, Vol. 2, 2012.

[8] Prasanna K. Lenka , Raka Kundu, Amlan Chakrabarti " Cobb Angle Measurement of Scoliosis with Reduced Variability ", International Journal of advanced Biomedical Engineering,Vol. 6, 2011.

[9] Zhang J., Lou E., Le L. H., Hill D. L., Raso J. V., Wang Y.," Automatic Cobb Measurement of Scoliosis Based on Fuzzy Hough Transform with
Vertebral Shape Prior", Journal ofDigital Imaging, Vol 22. No 5: 463-472, 2009.

[10]Sung-hoon Jeong, Sung-wook Shin, Jae-yong An, Sung-taek Chung," 3D Modeling of Musculoskeletal Cobb's Angles, 6th International Conference on Biomedical Engineering and Informatics (BMEI)" 2013.

[11]Liming DENGa, Han-Xiong LIa,Yong HUb, Jason P.Y.CHEUNGb, Richu JINb, Keith D. K. LUKb, Prudence W. H. CHEUNG,"Data-driven modeling for scoliosis prediction"International Conference on System Science and Engineering (ICSSE)2016.

[12]F. Altaf, A. Gibson, Z. Dannawi, and H. Noordeen, "Adolescent idiopathic scoliosis," Bmj, vol. 346, p. F2508, 2013.

[13]K. Ishida, Y. Aota, N. Mitsugi, M. Kono, T. Higashi, T. Kawai, K. Yamada, T. Niimura, K. Kaneko, H. Tanabe et al., "Relationship between bone density and bone metabolism in adolescent idiopathic scoliosis," Scoliosis, vol. 10, no. 1, p. 1, 2015.