Automatic Measurement of Surface Cobb Angle using Posterior View

Murtaza Aslam, Fozia Rajbdad, Jian Xu*
[1]*Electrical and Computer Engineering Department, Louisiana State University, USA*
jianxu1@lsu.edu

Faiza Rdad, Shoaib Azmat
[2]*Electrical Engineering Department, COMSATS University Islamabad, Pakistan*

Spine deformity detection from Cobb angle using radiographic images has significantly increased the risk of malignancies. Morphologic modifications of the trunk resulting in postural asymmetries are associated with deformities in the spine. The most common spine deformities are scoliosis and kyphosis. Scoliosis is the axial rotation of the spine [1], which occurs in 2-4% of the world population [2]. Radiographs of the spine while standing full-column remains the standard for analysis and curve observation [3]. The disadvantage of radiographs, particularly in young patients, is the exposure to ionizing radiation, which causes a significant increase in the risk of malignancies [4]. This paper proposes an automatic Cobb angle measurement method for detecting spine deformity from a single posterior image view. The spine waveform is acquired from the surface by detecting the center locations of markers attached to the spinous process using Hough transform and polynomial curve fitting (Figure 1). Surface Cobb angle is measured at the intersection of the tangent lines obtained from the derivative of the fitted curve. Cobb angle of each subject is also measured from x-ray by manual and computer-assisted methods (Figure 2). The linear regression method is applied to develop a correlation between surface and x-ray Cobb angles using a training dataset of 56 subjects (Figure 3). Two types of errors can occur during manual measurement, (i) the inter-observer error: the same subject is measured by different trainers, and (ii) Intra-observer error; the same subject is measured by the same trainer on different days intra. Cobb angle calculated using estimated regression equation for test dataset of 24 subjects has shown better coefficient of regression (R2) as compared to x-ray manual Cobb angle The estimated computer-assisted, and manual Cobb angles have shown percentage accuracy of 87.5 % and 70.83 % respectively within $\pm 10^{o}$ of estimated error as shown in figure 4. The statistical analysis results indicate that the proposed method is an accurate and consistent measurement of surface Cobb angle.

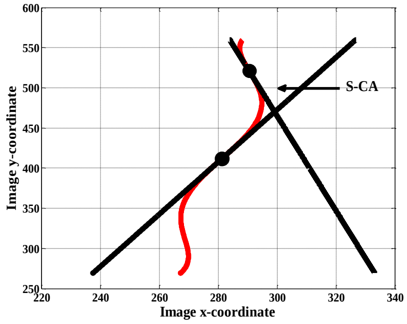
[1]Newton, P. O., Wu, K. W., Bastrom, T. P., Bartley, C. E., Upasani, V. V., Yaszay, B., & Harms Study Group. (2019). What factors are associated with kyphosis restoration in lordotic adolescent idiopathic scoliosis patients?. Spine Deformity, 7(4), 596-601.

[2]Bagheri, F., Razi, A., Birjandinejad, A., Amel Farzad, S., Peivandi, M. T., & Habibzade Shojaei, S. R. (2021). Congenital Scoliosis: A Current Concepts Review. Journal of Pediatrics Review, 9(2), 127-136.

[3] Fatima, J., Akram, M. U., Jameel, A., & Syed, A. M. (2021). Spinal vertebrae localization and analysis on disproportionality in curvature using radiography—a comprehensive review. *EURASIP Journal on Image and Video Processing*, *2021*(1), 1-23.

(a)

(b)



(c)

Figure 1: Surface-Cobb Angle (S-CA) measurements overview (a) Marked posterior surface view (b) Polynomial fitted spine waveform on the surface (c) Cobb angle measurement

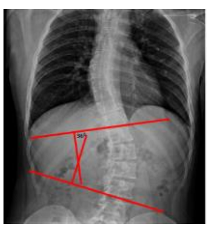
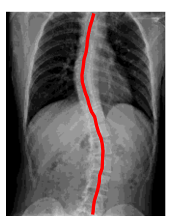
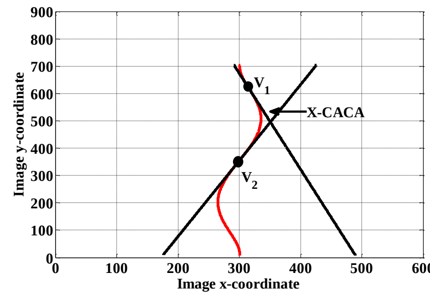


Figure 1: X-MCA measurement method

(a)

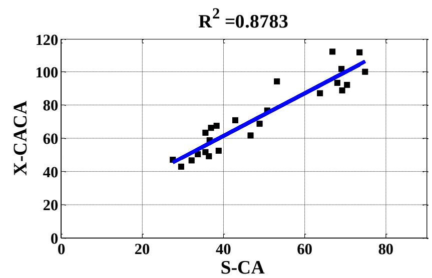


(b)

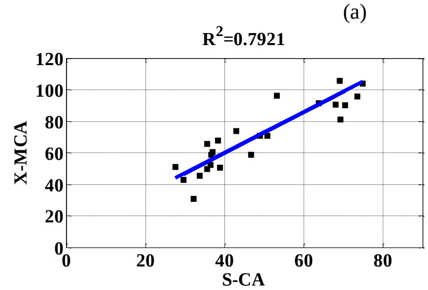


(c)

Figure 2: X-Computer assisted Cobb Angle(CACA) measurements overview (a) Spine boundaries traced with a computer mouse (b) Polynomial fitted spine waveform (c) Cobb angle measurement



(a)



(b)

Figure 3: Estimated linear regression lines for (a) S-CA versus X-CACA (b) S-CA versus X-ray Manual Cobb Angle (X-MCA)

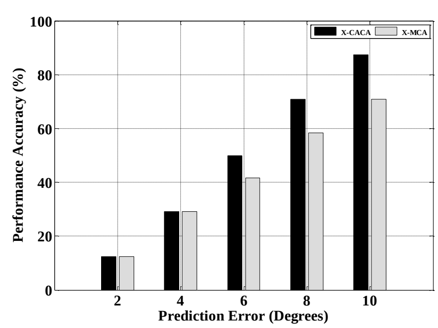


Figure 4: Prediction error in estimated Cobb angle

[4]Bradley, S. H., Abraham, S., Callister, M. E., Grice, A., Hamilton, W. T., Lopez, R. R., ... & Neal, R. D. (2019). Sensitivity of chest X-ray for detecting lung cancer in people presenting with symptoms: a systematic review. *British Journal of General Practice*, *69*(689), e827-e835