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Abstract

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Measuring an angle of the curvature of the spine with scoliosis on X-rays images

Joint with Paulina Galkowska and Barbara Jasiewicz

The work aims to propose a semi-automatic algorithm for calculation the Cobb's angle of the spines with scoliosis. The Cobb angle is used to assess the stage of the spine's deformation and is indicated on the X-ray images manually.

A proposed semi-automatic method for calculation the Cobb's angle was tested on the X-ray images presented children's spine with a different stage of scoliosis. Images were acquired as an element of routine treatment control, allowing to assess the results of treatment. Test images were acquired in the University Orthopedics and Rehabilitation Hospital in Zakopane. Radiograms show the spines of children with different types of scoliosis (scoliosis, kyphosis). Analysed radiographs had a relatively low quality due to high noise, and visible other anatomical parts aside from spine, such as ribs, what complicated the detection of the vertebral column. Radiographs of the spine were used in the posterior-front position. X-ray images have been appropriately processed using basic image transformation operations to remove noise, interference and unnecessary information.

The applied transformations are a median filter, histogram alignment, binarization, morphological gradient. The spine was described with the polynomial of the 5th degree (fig. 1, 2). Centroids were calculated using the k-means method. Based on this polynomial, the Cobb angle calculation was made using the straight-line equation passing through two points. The input data to the algorithm are the starting points in the places of the most significant span deflections from the y-axis. A function was created to generate these points according to the normal distribution, assuming as the peak the points giving the results closest to the measured manually. This affects the measurement error and spread of the Cobb angle values between the starting points in the closest neighbourhood. The occurrence and error value is reproducible for different pictures. The algorithm developed to calculate the Cobb angle can be used in diagnosing the progress of treatment. The calculated Cobb angle must, however, be treated as an angle with the computational error of the algorithm. Based on the results, decisions

on further treatment cannot be made because the error for some X-ray images is too large. The results of the algorithm can only help to confirm the progress of treatment that the doctor has established (Table 1).

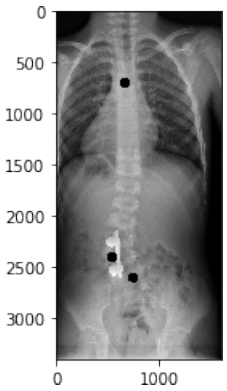

Figure 1: Points dividing the spine segments according to the type of scoliosis into subsegments.

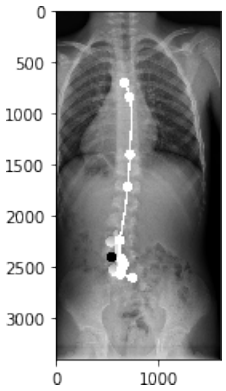

Figure 2: Interpolation of the line crossing the start points by 5th polynomial.

Table 1: Comparison of the results between the manually measured and calculated Cobb's angle

Patient	Year	Manually measured Cobb's angle	Calculated Cobb's angle	Difference
1	2012	35°	36°	1°
1	2013	29°	31°	2°
1	2015	23°	26°	3°
2	2015	24°	22°	2°
2	2016	21°	18°	3°
2	2017	20°	16°	5°
3	2013	12°	13°	1°
3	2014	8°	5°	3°
3	2016	4°	3°	1°