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INSIDE THIS ISSUE

PhD Title: Quantitative Analysis of Vertebral Parameters in Idiopathic Scoliosis Using Image Processing Techniques

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EDITORIAL

SADANAND B KULKARNI

Welcome to Jan-Feb issue of ENGMEDNEWS. It gives me distinct pleasure to enlighten all of you about the research work done on two articles that is published in this newsletter.

The first article mainly focuses on quantitative analysis of vertebral parameters in idiopathic scoliosis using image processing techniques.

The second article is about a device to restore brain functions via tongue.

I believe that these research works have uplifted the technology of medical world by making it cost effective and efficient.

I hope you all find this newsletter informative and useful.

Scoliosis (Ref. Figure 1) or curvature of the spine is one of the major skeletal diseases in adolescents. In majority of the cases cause is unknown or idiopathic. The progression of the disease occurs in three dimensions, with the spine simultaneously curving towards the arms and rotating as it collapses with the first indications usually being changes in body symmetry and back surface shape. Following diagnosis, most children do not exhibit any significant worsening of their condition and are routinely monitored using radiography as frequently as every three months. The MRI/CT are most accurate for assessing the disease, but it is strongly discouraged due to radiation hazards as patient requires continuous monitoring.

In interpreting the imaging features of scoliosis from the radiograph, it is essential to identify the significance of vertebrae in or near the curved segment (apex, end vertebra, neutral vertebra, stable vertebra), the curve type (primary or secondary, structural or nonstructural), the degree of angulations (measured with the Cobb method), the degree of vertebral rotation (measured with the Nash-Moe method), and the longitudinal extent of spinal involvement (according to the classification system). The measurement of these parameters needs to be reliable and reproducible as the treatment of idiopathic scoliosis is governed by the severity of the initial curvature and the probability of progression. The detailed study revealed inter and intra-observer errors caused by human intervention during quantification of these parameters. This thesis focuses on objective measurement of these three parameters using image processing without or with very minimum human intervention.

Figure 1: Scoliosis radiograph

Severity of the spine curvature in the lateral view is quantified by Cobb's angle as shown in the Figure 1. Quantification of Cobb's angle is based on the identification of vertebral end plates as well as manual landmark identification with ruler and pencil. This work proposed automatic identification of vertebral endplates by extracting the boundary of all vertebrae using image processing and angle calculation by slope intercept form. Firstly, using non-linear filters noise present in the radiograph is removed without blurring the expected edges. Segmentation of vertebral boundary has been done using active contour models, which result in complete morphometry of every vertebra. Later the vertical components of the boundary are extracted by morphological operation with structuring element in the vertical direction. Figure 3. The highest slope calculated from Hough transform helps to decide the vertebral endplates and Cobb angle is calculated with its intercept.

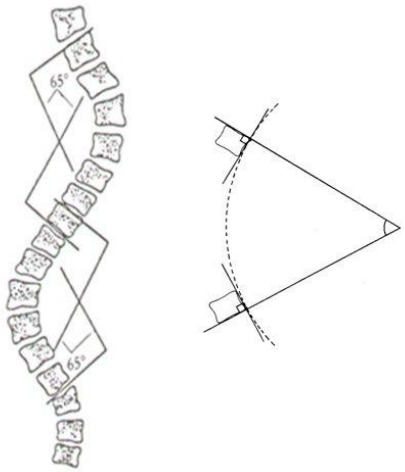


Figure 2. Cobb's angle

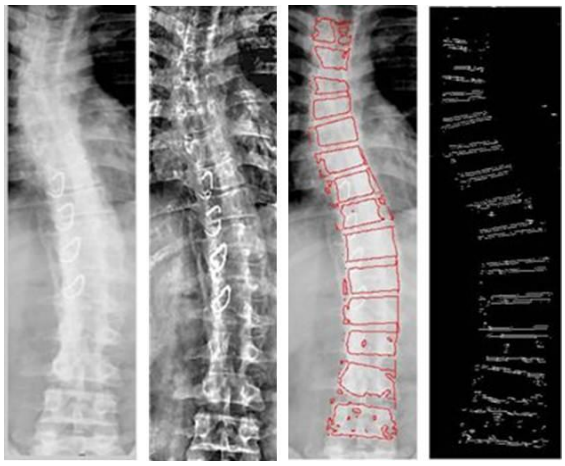


Figure 3: Retaining only horizontal plates of the vertebrae.

Scoliosis is a three dimensional deformity, only spinal curvature is not sufficient to estimate the extent of severity. This can be used along with vertebral rotation in the lateral direction, which is usually measured using Nash-Moe technique. Objective estimation of vertebral rotation involves identification of apical vertebra (i.e., highly deformed vertebrae). This research automates identification process using image processing, hence eliminates observer error in selecting the apical vertebra. The identified apical vertebra is divided into six equal segments in the lateral direction using the computer assisted method. The position of the pedicles within the segments is used as a measure for vertebral rotation as per Nash-Moe's definition as shown in Figure 4.

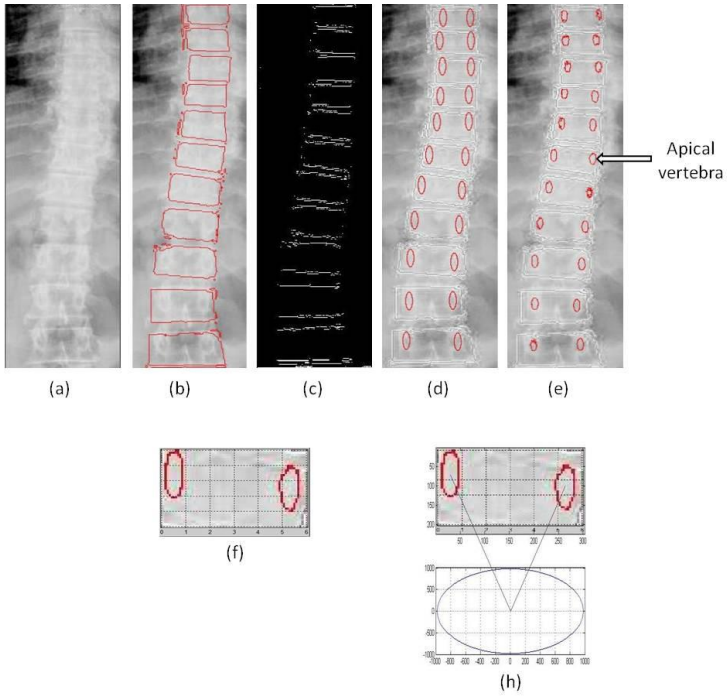


Figure 4: Identifying the apical vertebra and calculating angle of rotation

Classification of scoliosis is helpful in taking decision about treatment and severity of scoliosis. Classifications procedures are based on the presence of curves in different regions of spine as well its associated curvature. State-of-the-art classification procedures are based on the manual identification of the curve at different levels as well as its deviation. This research extracted only spine from the entire radiograph using customized filter and there by avoided misclassification due to unwanted regions. The central sacral line as well as medial axis is automatically identified as shown in Figure 5. These two

information are fed as input to the developed algorithm for automatic classification of scoliosis as per King's definition.

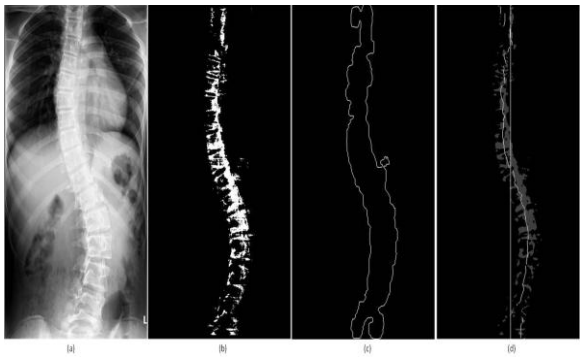


Figure 5: Identifying the medial axis line and central sacral line for classification

New device designed to restore brain functions – via the tongue

Scientists at the University of Wisconsin-Madison have created a device known as a Pons, that shows promise for the treatment of traumatic brain injuries, strokes, or the effects of diseases such as Parkinson's and multiple sclerosis. Researchers at the U.S. Army Medical Research and Materiel Command are now conducting a study on the device, which works by stimulating the patient's tongue.

The battery-operated Pons consists of a control/power box, and a flat electrode-covered oral portion that the patient holds in their mouth, against their tongue. In a typical 20 to 30-minute Pons session, the patient performs a set of physical, occupational, and cognitive exercises, tailored toward their disability.

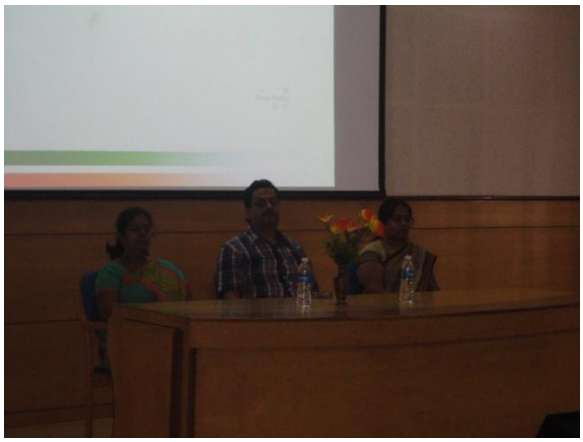
Each of those exercises are paired with specific patterns of electrodes being activated on the Pons, which in turn stimulate individual nerve endings on the tongue – the stimulation process is referred to as cranial nerve non-invasive neuro modulation.

By learning to associate specific nerve impulses from the tongue with specific activities, the brain reportedly starts to form new neural pathways for functions such as balance. Over time, this is said to increase its organizational ability, potentially allowing the patient to regain control of mental or physical functions.

In a study conducted at the University of Nebraska, a group of test subjects with multiple sclerosis received regular treatment with the Pons device. After eight weeks of therapy, they showed a "50 percent improvement in postural balance, a 55 percent improvement in walking ability, a 48 percent reduction in MS impact scores and a 30 percent reduction in fatigue."

In the latest study, the Army has joined forces with the University of Wisconsin-Madison and Neuro-Habilitation Corporation, which is commercializing the technology. The year-long evaluation of Pons will begin this month, and will focus largely on the treatment of brain-injured soldiers. It is hoped that the research will lead to U.S. Food and Drug Administration clearance for the device.

TELEMEDICINE



Biomedical Engineering Department at KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belgaum had organized a Guest lecture on Telemedicine on 16th Feb 2013. The resource person was our own renowned alumni Mrs. Deepa Prabhu, Scientist 'C', DRDO Bangalore.

All the faculty members and enthusiastic students of Bio-Medical Engineering Department were benefited by the lecture.

UPCOMING EVENTS:

1. **The Department of Medical Electronics of MSRIT in association with IEEE EMBS Bangalore chapter is organizing a five day workshop on Medical Fundamental to Advance, from 13 -17 March 2013 at MSRIT campus, Bangalore. www.msrit.edu**
2. **MEDITECH-13 is the National level technical symposium being organized by the Department Biomedical Engineering of Osmania University during 8th to 9 th March 2013. www.meditech2013.com**

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