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Computer Aided Detection of Spina Bifida Using Features Derived from Curvature Scale Space and Zernike Moments

Abstract

The work of this dissertation focuses on a specific computer aided diagnosis (CAD) problem, although the main concept can be generalized to similar problems. Our aim is to detect the presence of the *spina bifida* (open spine) neural tube defect that is evident for a physician when the fetal skull image of a subject is examined. The objective of applications performing automatic anomaly detection can be set in their original contexts. Such systems, as a second observer, may help avoid false diagnoses.

Fetal skull shapes possess markers that signal the presence of spina bifida. That is why this thesis concentrates on exploiting features extracted from skull shapes obtained via *ultrasound (US)*. Among the variety of shape representation and feature extraction schemes, we have implemented and experimented with two. Both the *curvature scale space (CSS)* and moment-based (i.e. *Zernike* moments) representations have proved to be robust in that the extracted features provide classification invariant under the similarity transformations of translation, rotation and scaling. Classification of shapes is commonly coupled with the problem of segmentation. Since the fully-automatic segmentation of US images is practically difficult, we have attempted to achieve segmentation semi-automatically after the manual marking of a small number of points on images, based on simple heuristics and the *Active Shape Models (ASM)*. Our experiments use *k-nearest neighbor (kNN)* and *Support Vector Machines (SVM)* classifiers. The inherent problem of rarity of medical data sets is tackled with methods of under-sampling and over-sampling. The results, reported for ground truth segmentations, reveal the availability of optimal operating points serving particular objectives.

PUBLICATIONS

Journals
1. **Umut Konur** , Fikret S. Gürgen, Füsun Varol, and Lale Akarun, "Computer aided detection of spina bifida using nearest neighbor classification with curvature scale space features of fetal skulls extracted from ultrasound images", *Knowledge Based Systems*, Vol: 85, pp. 80-95, September 2015, (SCI)

Conferences
1. **Umut Konur** and Fikret S. Gürgen, "Computer aided diagnosis for spina bifida", *International Symposium on Health Informatics and Bioinformatics (HIBIT 2010)*, 20-22 April 2010, Antalya, Turkey
2. **Umut Konur** , Fikret Gürgen, and Füsun Varol, "A two-view ultrasound CAD system for spina bifida detection using Zernike features", *SPIE Medical Imaging 2011: Computer Aided Diagnosis*, 12-17 February 2011, Orlando, USA

3. **Umut Konur**, Fikret Gürgen, ve Füsun Varol, "Elips oturtma ve aktif görünüm modelleri kullanarak fetal kafatası imgelerini bölütleme", *IEEE Sinyal İşleme ve İletişim Uygulamaları Kurultayı (SIU 2012)*, 18-20 Nisan 2012, Fethiye, Türkiye
4. **Umut Konur** and Fikret S. Gürgen, "Curvature-based multi-scale classification of fetal skulls for spina bifida detection", *International Conference on Applied Informatics for Health and Life Sciences*, 9-11 September 2013, Istanbul, Turkey

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Defense Date: 04.06.2015