TECHNICAL INSIGHTS

MEDICAL & DIAGNOSTIC IMAGING

TECHNOLOGY ALERT

PIXEL-VOXEL BASED MACHINE LEARNING ALGORITHM--DEVELOPMENTS IN MEDICAL IMAGE PROCESSING AND ANALYSIS

Traditional medical image processing algorithms for computer aided detection (CAD) of distinguishing cancerous lesions is based on the concept of machine learning algorithms. A typical machine learning algorithm works by determining optimal boundaries to separate classes in a multidimensional feature using input features such as contrast, area, and circularity. On a comparison note to existing machine learning algorithms, Pixel/voxel-based Machine Learning (PML) algorithms are increasingly being explored as a potential tool to avoid defects in common classifiers due to inaccurate feature calculation and segmentation. These algorithms directly utilize the pixel/voxel values in images as compared to the usage of input feature information.

A team led by Kenji Suzuki from the University of Chicago has been doing pioneering work in the design and development of PML algorithms. The team has long explored the concept of using PML as a universal tool for medical image processing and analysis. A few earlier applications include reduction of noise in X-ray images; enhance the contour of the left ventricle of the heart, separate bones from soft tissue in chest radiographs. With significant results, the researcher expanded image-processing PML to medical image analysis to detect lesions such as lung nodules and colonic polyps in X-ray and computed tomography (CT) images; to distinguish malignant and benign lesions. For applications in advanced image processing and analysis, Suzuki has developed and trained PML called massive-training artificial neural network (MTANN). "I developed and trained one of PML called a massive-training artificial neural network (MTANN) with input images and "teaching" soft-tissue images acquired with a special dual-energy radiography system. With the trained MTANN, I was able to suppress ribs in chest radiographs without any specialized equipment or any additional radiation dose to patients, unlike a dual-energy radiography system requires."

The researcher explained two major advantages of PML over other CAD algorithms. Firstly, conventional methods use redundant/unnecessary features, which might result in poor performance. This is rectified in PML as it does not require feature selection and pixel/voxel data are directly used. Secondly, these combined benefits offer room for no error due to segmentation when PML is implemented in practical applications. "I believe, and I [am] pretty certain that PML will be a main stream of disease classification. PML will replace existing methods. PML will create new applications that cannot be realized by using existing methods," he commented.

He also observes that the combination of PML with existing methods will result in a major shift of performance level in disease classification. His team is also actively working to develop PML. In this regard, the researcher expects a shift in PML's areas from focal lesions to diffuse diseases, from two-dimensional (2D)/3D to four-dimensional (4D) medical images, from anatomical imaging to functional imaging. The researcher has published several significant results in the area of PML in reputed journals. One of his recent publications titled, "CT Colonography: Computed-aided detection of false-negative polyps in a multicenter clinical trial," was published in the journal, *Medical Physics* (vol. 30, pp. 2-21, 2010).

Suzuki finally noted, "I heard that several major medical imaging companies and several venture computer-aided detection companies contacted the university intellectual property office. Interested companies can work with us in the development of their specific applications of PML with their funding help for us. Or, companies can work on their specific applications of PML. The companies need to obtain licenses from our university."

Details: Dr. Kenji Suzuki, Associate Professor, Room P-104A, Office of Department of Radiology Research, Medical Center, The University of Chicago, 5812 South Ellis Avenue, Chicago, IL. Phone: 773-702-6511. Fax: 773-702-0371. E-mail: Suzuki@uchicago.edu. URL: http://suzukilab.uchicago.edu.