Guest Editorial: Computer-Aided Detection or Diagnosis (CAD) Systems

COMPUTER-AIDED detection (CAD) is a clinically proven tool that increases the detection/diagnosis of cancers by assisting the physicians in decreasing observational oversights (i.e., decreasing the false negative rate), in detecting/grading cancers in the early stages and thus reducing the death rate with cancers, in improving inter- and intrareader variability. Furthermore, the state-of-the-art CAD systems have been widely used to assist physicians with various tasks, including providing second opinion to the detection and diagnostic processes and automatically identifying all noncalcified lesions suspected of malignancy at images. A CAD system may contain different components, such as detection, diagnosis, and risk assessment. Recent studies have proven that CAD systems are capable of revealing breast lesions on screening mammography. The idea of using a computer and CAD tools to help medical image diagnosis is not new. Some pioneer studies date back to the 1960s. The transition of CAD technologies from the research phase to industrial practice happened with the success of the Image CheckerTM in 1998. It was the first U.S. Food and Drug Administration (FDA)-approved commercial CAD system. Currently, several other CAD diagnostic imaging systems are commercialized. For example, FDA approved CAD products in the field of breast imaging (mammography, ultrasonography, and breast MRI); chest imaging [radiography and computerized tomography (CT)]; and LMS-Liver, i.e., an image visualization and analysis software package for the evaluation of liver lesions in CT images. Without CAD diagnostic imaging systems, recent radiological modalities, such as CT and MRI, could not even exist. Today, CAD has its enormous impact in the medical industry. All key companies in medical imaging have research laboratories devoted to CAD, and there are an increasing number of smaller companies active in the area. Furthermore, CAD techniques/devices have obtained great development and have attracted the attention from the experts in different fields.

However, the performance of the current CAD systems cannot meet the requirement of real applications. Thus, how to improve the performance of the CAD systems has become the main research task. As is well known, a computer-aided cancer detection and diagnosis system is not a simple system. It is the system of systems. The performance of a computer-aided cancer detection and diagnosis system needs large-scale integration of many independent and self-contained systems/parts to achieve the best performance. For example, the performance of a computer-aided cancer detection and diagnosis system depends on imaging systems, feature extraction and classification systems, and human computer interaction systems. Thus, in order to improve the performance of a CAD system, deep research of different key technologies in different subsystems used in a CAD system has become important and necessary. The aim of this special issue is to attract high-quality papers in key technologies used in computer-aided cancer detection and diagnosis systems and their subsystems, and we hope to promote the research and applications in computer-aided cancer detection and diagnosis systems. A number of papers were submitted to the special issue, and ten papers were selected for inclusion in the special issue.

Breast cancers are the second leading cause of death by cancers in women, and the early detection and treatment are critical for the reduction of associated mortality. There are five papers dealing with breast cancer detection and diagnosis. In the first paper of this issue, Liu *et al.* studied computer-aided breast cancer detection using mammography, and the research focused on the classification of masses. Different feature-selection methods and machine-learning algorithms were investigated, and they proposed a new feature-selection method, which was called support vector machine recursive feature elimination (SVM-RFE) with normalized mutual information feature selection (NMIFS) filter (or SRN). The new feature-selection method can obtain better classification results. Thermography has at least one advantage over mammography. The advantage is that thermography can identify much smaller tumors than mammography. This advantage makes thermography very useful for very early breast cancer detection because the very early tumors are generally very small. In the second paper, Krawczyk *et al.* proposed an effective approach for breast cancer detection and aimed to help doctors make medical decisions using thermography. Their approach used bilateral symmetry between the two breast regions from thermograms for breast cancer detection and diagnosis, and the experiments show that the proposed approach has great potential in breast cancer diagnosis. Dynamic contrast-enhanced magnetic resonance is an imaging modality, which offers some advantages over other imaging modalities, such as mammography and ultrasound imaging. It has been applied to breast cancer detection for some time. In the third paper, Soares *et al.* proposed a multiscale automated model for the classification of breast masses using the images from dynamic contrast-enhanced magnetic resonance. The proposed model offered high accuracy in distinguishing malignant lesions from benign lesions. Ultrasound technology has been used in breast cancer diagnosis because it is real time and emits no ionizing radiation. In the fourth paper, Ratnakar *et al.* studied ultrasound technology for tumor detection and developed an ultrasound system for tumor detection

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in soft tissues using low transient pulse. In the fifth paper, George *et al.* developed an intelligent remote detection and diagnosis system for breast cancer based on cytological images. They developed a new method for cell nuclei segmentation in the breast fine-needle-aspiration-cytopathology images and investigated different learning algorithms for breast cancer classification. They integrated the developed CAD system into a telemedicine platform, which will benefit breast cancer researchers and doctors.

Skin cancer is the most prevalent type of cancer, and dermoscopy imaging is an important imaging modality for skin cancer detection and diagnosis. Two papers studied CAD and diagnosis for skin cancer using dermoscopy imaging. In the sixth paper, Barata *et al.* presented two different systems for detecting melanomas in dermoscopy images. One of the systems used global features, and the other system used local features. Experimental results show that the system using local features has better performance than the system using global features. In the seventh paper, Celebi *et al.* proposed a machine-learning-based method for quantifying the clinically significant colors in dermoscopy images. The proposed method is segmentation free, easy to implement, efficient, and does not require a calibrated image acquisition system and thus provides better performance than many other existing methods.

Lung cancer is a common cause of death for both men and women. In the eighth paper, Pengo *et al.* developed a microscopy platform for early detection of lung cancer cells in bronchoalveolar lavage samples. The proposed platform can integrate image analysis routines easily. The platform was validated using an independent set of samples and was shown to have high performance. It provides a good platform for lung cancer detection and diagnosis.

Acute myelogenous leukemia (AML) is a subtype of acute leukemia, which is prevalent among adults. Currently, the detection of AML involves manual examination of the blood smear and is time consuming. In the ninth paper, Agaian *et al.* presented a simple technique that can detect and segment AML in blood smears automatically. The presented system performs automated processing, including color correlation, segmentation of the nucleated cells, and effective validation and classification. The proposed technique can obtain 98% accuracy for the localization of the lymphoblast cells.

As is well known, the gene regulatory network (GRN) is related with cancers. If we know the GRNs, it will be helpful for us to understand the rules that can be changed and the way that can be used to prevent a cancer candidate from developing cancer. In the tenth paper, Nguyen *et al.* proposed a computational process to determine the optimum alterations to induce to a given GRN, so that the potential for cancer is significantly reduced. The computational process is based on probabilistic Boolean networks and adopted genetic algorithms to realize the optimization process.

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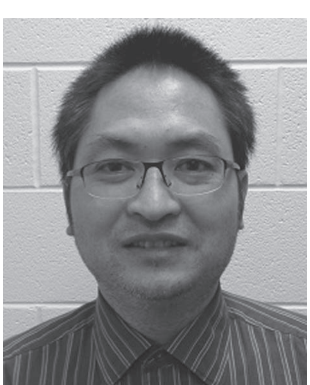

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