In diagnostic imaging, radiologists visually search for abnormalities on patient images. The accuracy of the process not only depends on the image quality and the reader's skill and vigilance, but also on the degree of complexity of the structured background and the characteristics of the abnormalities. Misdiagnosis may occur due to errors in detection or characterization. It has been shown that double reading can reduce misdiagnosis. However, double-reading by radiologists may not be practical because of the increased costs. Studies showed that computer-aided detection can improve radiologists' accuracy in detecting breast lesions in screening mammography. Laboratory observer performance experiments also indicated that computer-aided characterization can improve radiologists' accuracy in differentiating malignant and benign lesions. Computer-aided diagnosis (CAD) (used as a general term here to denote detection and/or characterization) is therefore considered to be a viable alternative to double reading.

To date several CAD systems are commercially available for screening mammography and one CAD system has been approved by FDA for lung nodule detection in chest radiography. CAD systems for mass detection in breast ultrasonography, lung cancer detection in computed tomography (CT), colon cancer detection in CT, and pulmonary embolism detection in CT are being developed. Potentially CAD can be applied to every diagnostic imaging task. At present, CAD systems are designed to be used as a second reader. The CAD system by itself is often less accurate than radiologists. In particular, a CAD system generally detects a large number of false positives. However, when the CAD system is used to alert the radiologist to suspicious lesions, the radiologist may be able to dismiss most of the false positives and recognize the true lesions. Prospective clinical studies using CAD have reported improvement in the sensitivity of breast cancer detection in screening mammography.

A CAD system generally involves several major steps: preprocessing, image segmentation, feature extraction, and feature classification. These steps are composed of a number of image processing and pattern recognition techniques. A CAD system is designed by using a large set of training samples collected for the specific task of interest. The image processing techniques and feature classifiers are then optimized based on the characteristics of the case samples. The generalizability of the trained CAD system to the patient population has to be validated by testing its performance in unknown case samples. In this talk, we will review some of the image processing and pattern recognition techniques used in current CAD systems, discuss some important issues involved in the development and evaluation of CAD systems, and explore future directions for CAD applications.

Educational Objectives:

1. Understand the concepts of CAD
2. Overview of current CAD applications
3. Review computer vision techniques used in CAD
4. Understand issues involved in development of CAD systems
5. Explore future directions