ABSTRACT

In breast cancer imaging many innovations continue to take place. This paper discusses computer aided detection (CAD) of breast cancer in mammograms, which is the first large scale application of independent computerized interpretation of radiological images. Thousands of systems have already been installed worldwide and use of CAD is rapidly expanding with the introduction of digital mammography. Despite this success, most radiologists believe that the performance of CAD should be improved to make it more useful. CAD algorithms do not yet operate at the level of performance of trained human readers, while there is no reason to doubt that this is an achievable goal.

The most common complaint of radiologists using mammography CAD is that current algorithms have too many false positives. Indeed, considering that current CAD algorithms operate at a level of one or two false positives per four view case case (MLO and CC views of the right and left breast), there are still a few hundred false positives for every true positive in a screening setting. When asked what is so bothering about false positives, some comment that they confuse them or slow down the reading. However, the worst aspect of false positives is that readers loose confidence in CAD, as they see many irrelevant CAD marks on obviously normal regions. They wonder how a system that operates so poorly in some aspects can ever help them.

Interestingly, experienced readers seem to have more faith in CAD than inexperienced readers. Perhaps experienced radiologists are more tolerant to false positives because they can easily dismiss them. They also recognize the main value of current CAD systems: the very high sensitivity. When reading fast, perceptual oversights occasionally occur, and CAD may help to avoid those. Of course, this is particularly important when there is no double reading. For less experience radiologists dismissing false positives is less easy, and they may have to spend a significant amount of time to interpret CAD marked regions.

The fact that CAD may confuse readers is an important message to CAD researchers. It reveals the rather obvious, but often neglected truth that radiologists have difficulty in interpreting mammographic regions and making the right decisions. In screening programs the decision to be made is if a woman should be recalled or not. Ideally, there should be a clear line between suspicious mammographic regions that require additional workup and other mammographic findings. Screening would then simply be the task of finding these regions, and misses could be classified as ‘search errors’. This simple model of breast cancer screening is often advocated by ‘expert’ screening radiologists and forms the basis of current CAD technology. CAD users are instructed to use the technology as a ‘checker’ to avoid oversights, but are discouraged to use it as an interpretation aid. Despite these clear guidelines, it is highly likely that many radiologists do use CAD as an interpretation aid when they become more familiar with the technique. They realize that the high negative predictive value of CAD is very valuable. Suppose a reader doubts whether to make a recall or not given the presence of an uncertain mammographic finding. When using CAD, the reader will know that the likelihood that a cancer is present becomes lower when CAD does not mark the region and higher when CAD does mark it, in particular if it is marked in multiple views. Using this information makes a lot of sense and will lead to better decisions on average. To this end, CAD information should be weighed properly, which is something the reader should learn from experience. This potential of CAD has been convincingly demonstrated in a study where CAD was combined independently with reader scores. To further explore the idea of using CAD as an interpretation aid an experimental environment was developed in which CAD information is presented interactively to the readers. First results obtained by this approach are very promising.

Modern breast imaging is becoming increasingly complex with the introduction of new modalities. Contrast enhanced MRI is nowadays widely used, for instance in high risk screening programs, while novel modalities as automated whole breast ultrasound and tomosynthesis are expected to play an important role in the near future. To meet demands of radiologists, CAD methods have to be developed that can integrate multimodal image information in intelligent decision and navigation support applications.

Index Terms— Breast Cancer, Computer Aided Diagnosis