Linking Image Structures with Medical Ontology Information

Da Qi[1], Erika R.E. Denton[2], and Reyer Zwiggelaar[1]

[1] Department of Computer Science,
University of Wales,
Aberystwyth SY23 3DB, UK
[2] Norfolk and Norwich University Hospital,
Norwich NR4 7UY, UK
ddq04@aber.ac.uk, rrz@aber.ac.uk

Abstract. Medical ontologies are being developed with some of these specifically for mammographic computer aided diagnosis (CAD) systems. However, to provide full functionality for such mammographic CAD systems it is essential that the ontology information is fully linked to the image information. This linking can be through problem specific image attributes. However, such an approach tends to be non-generic. Here, we propose a framework that will use generic image structures and the topology that links the image structures. In the process we describe a comparison approach which takes the classes, attributes and semantics into account.

1 Introduction

A large number of medical ontologies have been developed in recent years [1, 2, 3, 4, 5, 6]. Recently, mammographic ontologies have been developed, with an emphasis on triple assessment [7], computer aided diagnosis systems [8] and abnormality detection by expert radiologists [8]. A typical example of the high level structure of such an ontology is shown in Fig. 1. At a lower level (details can be found in Fig. 2) the ontology indicates attributes of the abnormality (e.g. size and shape descriptors), but also include associated findings of additional abnormalities (e.g. the association between calcifications and masses or deformity). The final part of a mammographic ontology consists of semantic aspects, which include a) a description of how the values of the attributes, in combination with specific abnormality classes, lead to classification of the abnormality [9], b) spatial relationships and associations between abnormality classes [10], c) synonyms for abnormality classes and attributes [11], d) spatial relationships between abnormalities and image location [12]. The specific values of the attributes and the association between the various abnormalities in combination with some suitable logic will determine the classification of the mammographic images. A typical five point score scale would be: 1. normal, 2. benign, 3. indeterminate (probably benign is also used), 4. probably malignant, and 5. definitely malignant. Such classification will determine the subsequent process.

In breast screening programmes [13, 14, 9] the emphasis in detecting abnormalities is on image information [15, 16, 11]. However, very little work has been done to

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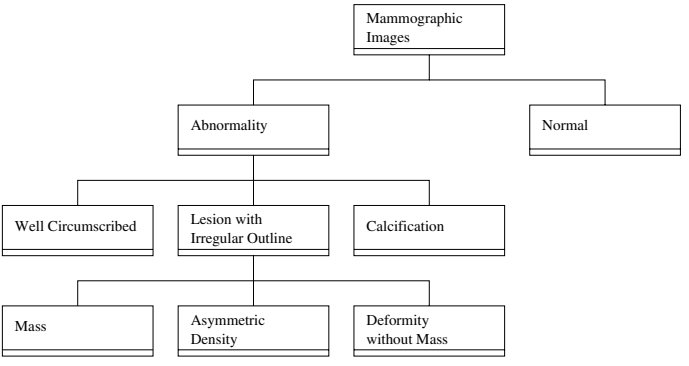

Fig. 1. High level structure of the mammographic ontology

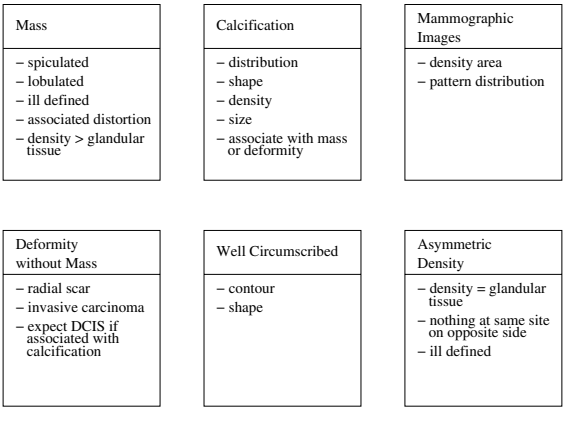

Fig. 2. Attribute details of the mammographic ontology

date to provide a clear link between the mammographic ontologies and generic image structures present in mammographic images. This is a theoretical investigation into the topological representation of medical ontologies and how these are linked to the available image information. More specifically, the investigation provides direct mapping between a radiologists mammographic ontology and image structures. The comparison is provided at all levels of the ontology, covering classes, attributes and semantics. This is closely related to the work on image topologies [17], ontologies [18, 19] and mereotopology [20, 10]. It is expected that such semantic enrichment will lead to an improved image understanding. This work is based on collaboration with expert breast-screening radiologists and is expected to be incorporated within future CAD, eLearning and image retrieval systems.

The layout of the remainder of the paper will be as follows. In Sec. 2 an image formation model is developed, which forms the basis for a mammographic image model. Subsequently, a string comparison approach is described to provide a mapping between the mammographic ontology and image model. Results, application areas and