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QUANTITIATIVE IMAGE ANALYSIS IN MAMMARY GLAND MORPHOLOGIES

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ABSTRACT

Motivation:
The mammary gland is crucial for the survival of mammalian species, because it provides the only source of nutrients for young offspring. To generate as much milk-producing tissue as possible in the limited fat pad space available, the mammary gland epithelium undergoes extensive branching and budding. A lactation deficiency may be caused by changes in these developmental aspects. To quantify these changes, biologists currently rely on simple software that requires tedious manual manipulation, and moreover, is both inconsistent and not objective. To overcome these issues, we aim to develop fully automated, objective and consistent mammary gland quantification tools.

Result:
In this work, some quantification image analysis methods are developed to automatically measure relevant parameters including the epithelial occupancy of the fat pad, extent of branching, bud formation, ductal length/width, etc. Our method to measure occupancy consists of applying a sequence of morphological operations [1], while the other method for extracting branching information is inspired by some advanced algorithms [2] for the quantification of angiogenesis. We tested our method with images at different magnifications of murine mammary glands at various stages of development. For the high magnification images, the results correctly segment the mammary branches, and give some useful statistical information about the branches such as their lengths and widths as well as the number of branching points, end points etc. (see Fig. 1). For the low magnification images, the results correctly indicate the outlines of the mammary epithelium and the fat pad, which is used to calculate the epithelial occupancy of the fat pad (see Fig. 2). These methods provide rapid automated

quantitation of developmental aspects of the mammary gland, and allow biologists to objectively correlate morphogenesis to functionality.

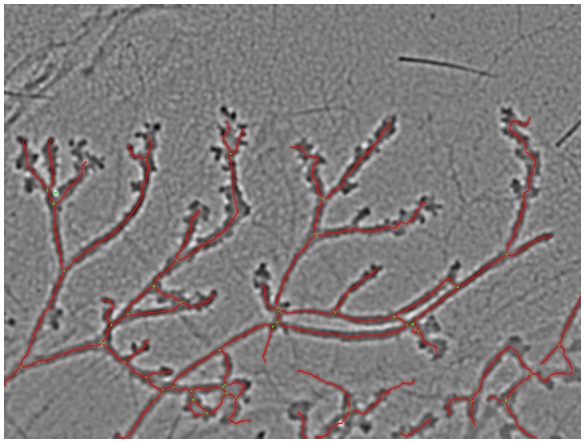

Figure 1: High magnification image of seven months virgin glands. Information obtained from the segmentation result: (a) Average branch length = 0.48mm; (b) Average branch width = 0.08mm; (c) number of branching points = 43; (d) number of end points = 37.

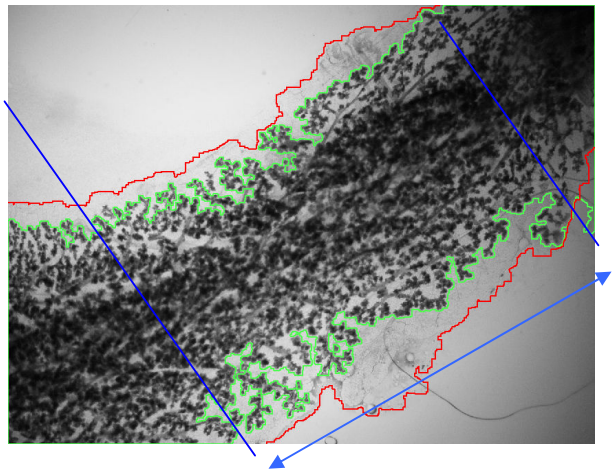

Figure 2: Low magnification image of four months pregnant glands. Information obtained from segmented result: (a) Average extent of growth towards width: 62.5 pixels; (b) Epithelial occupancy of the fat pad = 67%.

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