Image analysis techniques for classification of pulmonary disease in cattle

Denise Miller\textsuperscript{a}, Gary Wobeser\textsuperscript{b}, Greg Appleyard\textsuperscript{c}, Mark Eramian\textsuperscript{d}, and Tony Kusalik\textsuperscript{d}

\textsuperscript{a}Dept. of Biomedical Engineering, University of Saskatchewan, Saskatoon, SK;  
\textsuperscript{b}Dept. of Veterinary Pathology, University of Saskatchewan, Saskatoon, SK;  
\textsuperscript{c}Provincial Laboratory for Public Health, Calgary, AB;  
\textsuperscript{d}Dept. of Computer Science, University of Saskatchewan, Saskatoon, SK

1. INTRODUCTION

Analysis of tissue samples is a time-consuming task for pathologists. Traditional manual assessment techniques are also subjective. Computer-based quantitative analysis of tissue samples shows promise for eliminating the subjectivity of the assessment, as well as potentially eliminating a backlog of pathology work. Although the ultimate goal of computerized analysis would be a fully automated diagnosis, significant benefits can also be realized from software which determines the presence of disease-indicating features within the samples, highlights these areas for pathologists, and produces measurements of these relevant features. The objective of this project is to create software which can be used as such a diagnostic aid in pathology assessments.

2. METHODS

Data
The source data for this project consists of cattle lung samples on standard glass microscope slides. Digital images of the tissues are produced using a Trestle digital slide scanner. All images use 24-bit colour.

Disease-Indicating Features
For this project, the software detects and measures the following subset of disease-indicating features: amount of fluid-filled vs. air-filled alveolar space, areas of inflammation, and presence and amount of necrosis and fibrin.

Image Processing Techniques
Image processing techniques used in this project utilize colour, edge and texture properties of the images individually, as well as in combination, to locate disease-indicating features. For assessment of alveolar contents, colour information is used to detect alveolar boundaries. Due to variations in staining between slides, and also within individual slides, absolute colours can not be used. However, classification of relative colours using k-means clustering has successfully segmented inner alveolar spaces from other parts of the tissue. Detection of alveolar boundaries is further improved using a morphological operation and image subtraction. For detection of areas of inflammation, texture properties, including edge frequency and edge density, are used to detect the clumps of nuclei of macrophages and/or neutrophils which characterize these sites. Detection of areas of necrosis and fibrin within the tissues utilizes a combination of both colour and texture properties. In this case, a region splitting and merging algorithm is used.

3. RESULTS AND CONCLUSION

The software is able to successfully detect alveolar boundaries, and to determine the overall amount of fluid-filled vs. air-filled alveolar space in each tissue sample. The software successfully isolates areas of inflammation within the tissues, and measures the total tissue area that is affected. Detection of areas of necrosis and fibrin has proved to be the most challenging aspect of this project. Segmentation of these areas of the tissue images has been reasonably successful, with additional improvements still in progress.

REFERENCES


Further author information: (Send correspondence to Denise Miller)  
Denise Miller: E-mail:cdm027@mail.usask.ca, Telephone: 1 306 966 1495