### FACULTY OF SCIENCE UNIVERSITY OF COPENHAGEN

# **Texture Analysis and Multivariate Classification models in CT Images from dogs with Pulmonary Thrombosis**

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#### Introduction

Computed Tomography Pulmonary Angiography (CTPA) is considered as gold the standard for diagnosing pulmonary thromboembolism (PTE) in humans [1][2]. Pulmonary thromboembolism can result in the obstruction of one or more pulmonary vessels by a blood clot and may be identified on CTPA as partial or complete intraluminal fillings defects or abrupt cut-off of the pulmonary arteries after con trast injection.

The mortality rates of pulmonary thromboembolism (PTE) in small animals are unclear and probably significant. Survival depends on early diagnosis and early appropriate therapy.The interpretation of CTPA images is highly dependent on the availability of experienced radiologists.

#### Results



In order to asssit the radiologists by providing an objective classification of the images, we have decided to explore the texture in the CTPA scans using gray-scale level co-occurrence matrices (GLCM) [3], at the pixel value level and use partial least squares-discriminant analysis (PLS-DA) for classification purposes.

## Aims

Our aim was to examine the usefulness of a statistical approach to discriminate between healthy and diseased lung tissue. Additionally,we would like to establish a method for distinguishing PTE from other lung conditions with the use of Image analysis techniques in CTPA scans.

# **Materials & Methods**

raw data CTPA scans of 35 dogs (~50-150 slices per dog))

lung segmentation

Fig.1 Scores (a) and Loadings plot (b) of PLS-DA model in the first 2 LVs. In the scores plot (a) the green dots are the healthy dogs, the dark blue dots are diseased dogs diagnosed with Pulmonary throembolism and the cyan dots are the diseased dogs without pulmonary throembolism.

#### **ROC curves of PLS-DA classification**





n = 3070	11  K = 12 / 0	11  K = 81 70
C= 96%	SPC = 91%	SPC = 77%
ROSS-TPR = 96%	CROSS-TPR = 0,39%	CROSS-TPR = 70%
ROSS-SPC = 95%	CROSS-SPC = 85%	CROSS-SPC = 74%
PR =True Positive rate (sensitivity) PC=True Negative Rate(spesificity)		cross validation line
ROSS= cross validation		estimated line

Fig.2 Illustrates the ROC(Receiver operating Characteristics) curves of the cross-validation (green line) and estimated (blue line) of the PLS-DA algorithm for the three different groups (healthy (a), diseased with PTE(b) and diseased without PTE(c))

# Conclusion

SP

CF CF

SF

• The evaluation of the PLSDA performance demonstrated adequate results; discriminating healthy from diseased lung tissue was performed with approximately 98% sensitivity and 96% specificity.

• Energy and entropy (textural features) always showed negative correlation in the loadings plot, with entropy having high values and energy law values. This combination reveals that the corresponding CTPA scans are homogeneous. This combination of variables was always associated with the healthy group in the scores plot.

• Homogeneity showed positive correlation with inverse difference normalized and inverse different moments normalized, while all of them had low values in the loadings plot. This combination of textural features is evidence that the diseased group CTPA scans have inhomogeneous texture.

• The results obtained in this work are extremely promising with respect to the capability of image and multivariate data analysis in the medical imaging framework. Although, the sensitivity and specificity for discrimination between diseased dogs with PTE and diseased dogs without PTE were not ac-



ceptable using PLSDA, there are several lines of research arising from this work, which may be pursued that may improve performance.



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